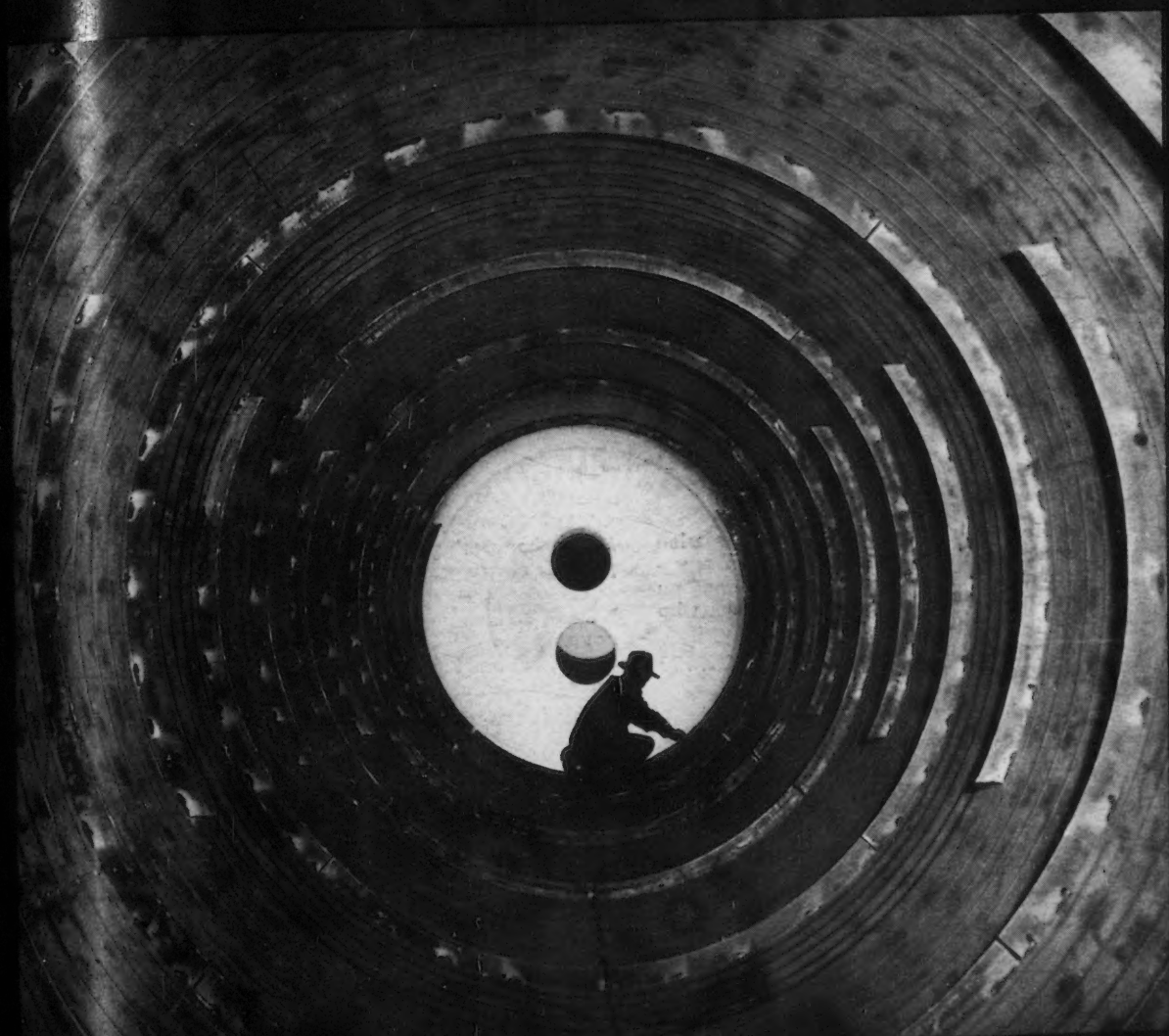
Corrosion

Official Publication
NATIONAL ASSOCIATION OF CORROSION ENGINEERS



ANSWERS TO *OUR* QUESTIONS ABOUT NO-OX-ID RUST PREVENTIVES

● Here are the high points of a discussion recently held between a Dearborn representative, who *asked* the questions and an executive engineer of a major gas line who supplied the *answers:*

Q. How long have you used NO-OX-ID? **A.** Ten years.

Q. Uninterruptedly? **A.** Yes.

Q. Have you ever been disappointed? **A.** Certainly not, the results have been good.

Q. Can you name a specific performance? **A.** Yes, 10 years without a leak or replacement with soil resistance at 750 to 1200 ohms per cubic centimeter.

Q. What protection did you use prior to NO-OX-ID and what was your experience? **A.** Another coating that gave us an average pipe life of two years.

Q. Comparatively speaking, have you found NO-OX-ID applications cost less? **A.** Yes, not only with maintenance crews but some contractors on "big inch" lines have bid an average of five cents per foot less.

This is typical of the regard of users for NO-OX-ID Rust Preventives in every pipe line service.

Consult with your Dearborn Engineer. There are versatile NO-OX-ID coating combinations for new or reconditioned lines . . . hot or cold application . . . for every climate and soil condition.

DEARBORN CHEMICAL COMPANY
General Office: 310 S. Michigan Ave., Chicago 4, Ill.

"Piping Hot," an interesting, full-color, 16mm sound movie demonstrating the use of hot applied NO-OX-IDs by stationary machine, is available for booking by companies, engineering clubs or technical societies. Write . . .

Dearborn
Reg. U.S. Pat. Off.

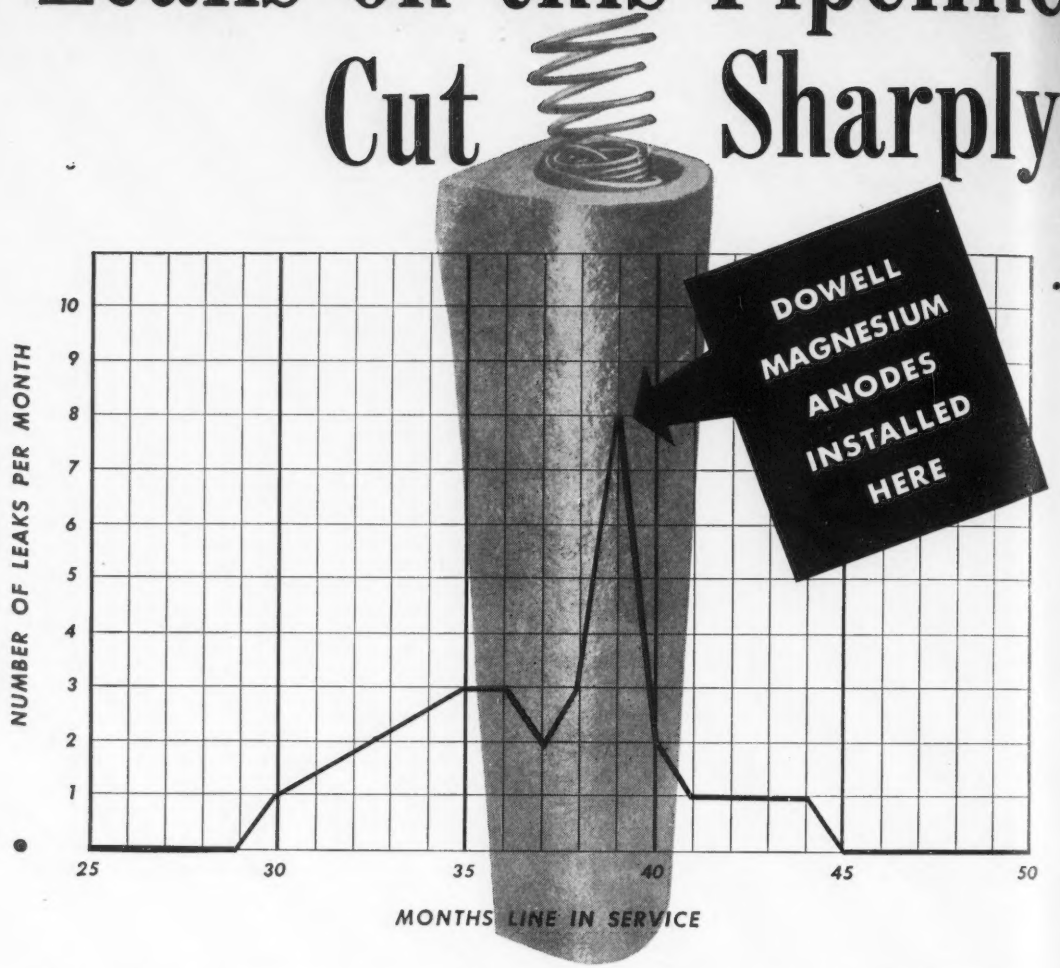
NO – OX – ID
IRON + OX = RUST

THE ORIGINAL RUST PREVENTIVE

Putting Permanence
in Pipe

MAYES BROS.
INCORPORATED
HOUSTON

Leaks on this Pipeline Cut Sharply



The graph above shows the dramatic reduction in leak rate that occurred when Dowell magnesium anodes were installed on a 33 mile 8 inch asphalt covered pipe line. This installation saved thousands of dollars in maintenance costs alone, as well as extending indefinitely the time when the line would have to be reconditioned or replaced.

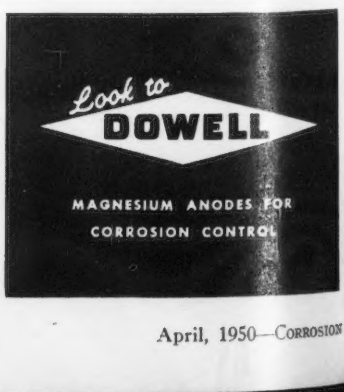
This is an example of the savings that can result when Dowell anodes are used to control corrosion on underground pipelines. The degree of protection afforded will depend upon soil conditions encountered and the number of anodes used. Easily and economically installed on existing pipe lines, Dowell magnesium anodes require no external power and cut maintenance costs to a minimum. Also, Dowell anodes are alloyed to specifications designed for maximum anode efficiency and long life.

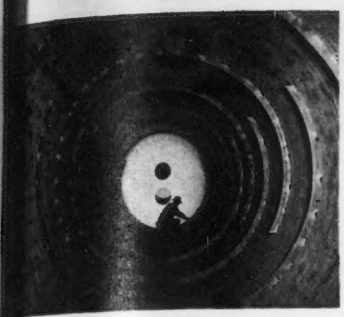
A subsidiary of The Dow Chemical Company — pioneer in the use of magnesium for cathodic protection —Dowell offers the technical know-how and extensive research facilities which make it the logical source for magnesium anodes for corrosion control. Write directly to Tulsa for additional information.

DOWELL INCORPORATED
TULSA 3, OKLAHOMA

DOWELL
MAGNESIUM ANODES
GALVO-PAK • GALVO-LINE

SUBSIDIARY OF THE DOW CHEMICAL COMPANY





THIS MONTH'S COVER—Interior of this 8 foot diameter by 50-foot fluid catalytic tower lined with 12-gauge stainless steel strips for resistance to corrosion at high temperatures by sour crude is being inspected at the Nooter Corporation's St. Louis, Mo. plant. The tank was built and lined by the St. Louis firm. Shell material is ⅝-inch steel.

☆

STAFF

EDITORIAL

IVY M. PARKER—*Editor*

NORMAN E. HAMNER—*Managing Editor*

CORRESPONDENTS

B. B. MORTON—*Non-Ferrous Metals*

HENRY W. FOELSCH—*Pulp, Paper, Mining and Food*

ARBA H. THOMAS—*Ferrous Metals*

E. R. BEGOLE—*Petroleum Production and Transportation*

IRWIN C. DIETZE—*Power*

GUSTAVE HEINEMANN—*Chemical Process*

R. H. BROWN—*Light Metals*

DERK HOLSTEYN—*Petroleum Refining*

J. M. STANDRING—*Telephone, Telegraph, Radio*

R. MCFARLAND—*Non-Metals*

L. M. MOSHER—*Transportation Industry*

A. J. GATES—*Water Works*

ADVERTISING

A. B. CAMPBELL—*(Executive Secretary of NACE) Advertising Manager*

☆

GENERAL OFFICES

919 Milam Building
803 Texas Avenue
Houston 2, Texas

Subscription: $7.50 per year to non-members; Member's share $7.50, of which $3.00 are applied as subscription to CORROSION; Special rate, $3.50 per year for public and educational libraries. Additional copies to members 50 cents, to non-members, 75 cents. Foreign remittances should be by international postal or express money order or bank draft negotiable in the U. S. for an equivalent amount in U. S. funds.

Entered as second class matter October 31, 1946, at the Post Office at Houston, Texas, under the act of March 3, 1879.

CORROSION is Indexed Regularly by Engineering Index.

CORROSION devoted entirely to CORROSION Research and Control

Published monthly as its official journal, by the National Association of Corrosion Engineers, Inc., at Houston, Texas, U. S. A., to provide a permanent record of progress in the control of corrosion as described in papers prepared for the Association and from other sources.

VOL. VI APRIL, 1950 No. 4

CONTENTS

Page

Directory of NACE Regional and Sectional Officers iv
Directory of Technical Practices Committee Officers v

TECHNICAL SECTION

Oil and Control Wear
By R. E. Jeffrey and J. M. Plantfeber 115

Field Experience With Corrosion Protection of Galvanized Steel Substation Structures
By Siebert L. Miller 120

Corrosion of Steel Pipe by Chlorinated Seawater at Various Velocities
By V. B. Volkening 123
Discussion: Gustave Heinemann, Page 127; F. L. LaQue, Page 128

The Corrosion Products on Zinc Anodes Used Underground
By E. A. Anderson 129
Discussion: Sidney E. Trouard, Page 131

Field and Laboratory Tests of Sodium Chromates and Alkalies for Controlling Corrosion in Gas-Condensate Wells
By C. K. Eilerts, R. V. Smith, F. G. Archer, L. M. Burman, Faye Greene and H. C. Hamontre 131
Discussion: Edward C. Greco, Marc Darrin, Page 134; H. E. Waldrip, R. McFarland, Page 136

NEWS SECTION

Topic of the Month—Recent Developments in Glass-Lined Pipe
By S. C. Orr 1
Dow Installation at Freeport Toured 3
North Texas Section Hears Valve Talk 3
Metallizing, Parkerizing Featured at Western Region Meeting 4
Emphasis Placed on Practical Topics at Tulsa Pipeliners' School 6
South Central Region to Meet Oct. 9-10 7
TP-1A Pacific Coast Objectives Given 8
Procedure on Distribution of TP Reports 8
St. Louis Committee Meetings Schedule 10
Changes in Conference, Exhibit Program 11
Additional Copies of Austin Short Course Lectures Considered 12
Corrosion Problems 13
NACE New and Reinstated Members 14
Corrosion Mitigation Discussed at UN 19
New Products 22

CORROSION ABSTRACTS SECTION

Index to Corrosion Abstracts on 24

INDEX TO ADVERTISERS 47

Copyright 1950 by the National Association of Corrosion Engineers. Reproduction of the contents, either as a whole or in part, is forbidden unless specific permission has been obtained from the Editor of CORROSION. Articles presented represent the opinions of their authors, and not necessarily those of the Editors of CORROSION, nor the Officers or Members of the National Association of Corrosion Engineers. Manuscripts to be considered for publication should be forwarded, together with illustrations, to the Editor of CORROSION, 919 Milam Building, Houston 2, Texas.

Directory of NACE Regional and Sectional Officers

NORTH EAST REGION

R. H. LYNCH, Director
Keystone Pipe Line Co.,
260 South Broad Street,
Philadelphia 1, Penna.

LEWIS B. DONOVAN, Chairman
Consolidated Edison Co.
of New York Inc.,
4 Irving Place,
New York 3, N. Y.

HUGH L. HAMILTON,
Vice-Chairman
Keystone Pipe Line Co.,
260 S. Broad St.,
Philadelphia, Pa.

E. ROWLAND ENGLISH,
Sec.-Treas.
H. C. Price Co.,
P. O. Box 6120,
Philadelphia 15, Pa.

• Metropolitan Section (N.Y.)

T. P. MAY, Chairman
International Nickel Co., Inc.
67 Wall Street
New York 5, N. Y.

H. W. WAHLQUIST, Vice-Chair.
Ebasco Services, Inc.,
2 Rector Street,
New York, N. Y.

F. J. LeFEBVRE, Sec.-Treas.
Electro Rust-Proofing Corp.
(N. J.)
1 Main Street,
Belleville 9, N. J.

• Philadelphia Section

ROBERT R. PIERCE, Chairman
Pennsylvania Salt Mfg. Co.,
1000 Widener Bldg.,
Philadelphia, Pa.

HENRY F. McCONOMY, Vice-Chair.
The Atlantic Refining Co.,
P. O. Box 8138,
Philadelphia, Pa.

ERNEST H. WYCHE, Sec.-Treas.
Lukens Steel Co.,
Coatesville, Pa.

• Baltimore Section

EDGAR F. WOLF, Chairman
Cons. Gas Electric Light and
Power Co. of Baltimore,
531 East Madison St.,
Baltimore 3, Md.

HOMER D. HOLLER, Vice-Chairman
National Bureau of Standards,
Room 207, East Building,
Washington 25, D. C.

GEORGE E. BEST, Sec.-Treas.
Mutual Chemical Co. of Am.,
1348 Block Street,
Baltimore 31, Md.

• Pittsburgh Section

RUSSELL H. COE, Chairman
Pittsburgh Coke & Chemical
Co., P. O. Box 1645,
Pittsburgh 19, Pa.

V. V. KENDALL, Vice-Chairman
National Tube Co.,
Box 266,
Pittsburgh, Pa.

J. M. BIALOSKY, Treasurer
Carnegie-Illinois Steel
Corp., 210 Semple St.,
Pittsburgh 13, Pa.

E. D. VERINK, JR., Secretary
Aluminum Co. of America,
P. O. Box 1012,
New Kensington, Pa.

W. W. BINGER, Asst. Secretary
Research Laboratories,
Aluminum Co. of America,
New Kensington, Pa.

NORTH CENTRAL REGION

N E. BERRY, Director
Servel, Inc.
119 N. Morton Ave.,
Evansville, Ind.

L. G. VANDE BOGART, Chairman
Crane Co., Engineering & Res.
Div., 836 South Michigan Ave.
Chicago 5, Illinois

WALTER J. SANDEL, Vice-Chair.
Coatings for Industry, Inc.
2185 East 18th Street,
Cleveland 15, Ohio

R. A. SHOAN, Sec.-Treas.
Dearborn Chemical Company,
1029 West 35th Street,
Chicago 9, Illinois

• Chicago Section

J. PAT CASEY, JR., Chairman
Crane Company,
836 South Michigan Ave.,
Chicago 5, Illinois

V. J. PAYTON, Vice Chair.
Commonwealth Edison Co.,
72 W. Adams Street,
Chicago 90, Illinois

• Cleveland Section

E. W. VEREEKE, Chairman
Heil Process Equip. Corp.
12901 Elmwood Ave.,
Cleveland, Ohio

RAYMOND B. HOXENG, Vice-Chair
University Circle
Case Institute of Tech.
Cleveland, Ohio

J. A. THORNTON, Sec.-Treas.
Cleveland Tool & Supply Co.
1427 W. 6th Street,
Cleveland, Ohio

• Greater St. Louis Section

PHILIP H. SMITH, Chairman
Nooter Boiler Works,
St. Louis, Mo.

FRANK L. WHITNEY, JR.,
Vice-Chairman
Monsanto Chemical Co.,
St. Louis, Mo.

E. L. RICE, Sec.-Treas.
National Lead Co.,
St. Louis, Mo.

WM. F. GROSS, Corres.-Sec.
Tretolite Co.,
937 Pacific Ave.,
St. Louis 19, Missouri

SOUTH EAST REGION

JAMES T. MacKENZIE, Director
Amer. Cast Iron Pipe Co.,
P. O. Box 2603,
Birmingham 3, Alabama

J. W. YELDELL, Chairman
Southern Natural Gas Co.,
Box 2563,
Birmingham, Ala.

E. P. TAIT, Vice-chair.
Alloy Steel Prod. Co.,
Candler Bldg.,
Atlanta, Ga.

J. F. JOHNSTON, Sec.-Treas.
Am. Telephone & Tel. Co.,
51 Ivy St., N. E.,
Atlanta, Ga.

SOUTH CENTRAL REGION

L. F. SCHERER, Director
Texas Pipe Line Co., Box 2332,
Houston 1, Texas

TOM R. STATHAM, Chairman
Magnolia Pipe Line Co.,
Dallas, Texas

GEORGE A. MILLS, Vice-Chair.
Central Power & Lt. Co.,
Corpus Christi, Texas

M. C. FLEMING, Sec.-Treas.
Phillips Petroleum Co.,
Bartlesville, Okla.

HARRY E. WALDRIP, Asst. Sec.-
Treas.
Gulf Oil Corp.,
Houston, Texas

• Tulsa Section

F. T. GARDNER, Chairman
University of Tulsa,
Tulsa, Okla.

F. E. PYEATT, JR., Vice-Chairman
Mid-Continent Pipe Line Co.
P. O. Box 381
Tulsa 2, Okla.

FRANK E. McNULTY, Sec.-Treas.
Pittsburgh Coke & Chem. Co.
Room 711, Thompson Bldg.,
Tulsa, Okla.

• Houston Section

JACK L. BATTLE, Chairman
Humble Oil & Ref. Co.
P. O. Box.2180
Houston 1, Texas

A. L. STEGNER, Vice-Chair.
Tennessee Gas Trans. Co.
P. O. Box 2511
Houston 1, Texas

PERRY P. SPAFFORD, Sec.-Treas.
Stanolind Oil & Gas Co.
P. O. Box 3092
Houston 1, Texas

• Shreveport Section

M. W. BELSON, Chairman
D. E. Stearns Co.
P. O. Box 1234
Shreveport, La.

H. V. BEEZLEY, Vice-Chair.
United Gas Corp.,
Shreveport, La.

M. J. OLIVE, Secretary
Arkansas Natural Gas Co.
Shreveport, La.

J. A. CREEVY, Treasurer
Youngstown Sheet & Tube Co.
Shreveport, La.

• North Texas Section

K. D. WAHLQUIST, Chairman
6281 Revere Place
Dallas 14, Texas

JOHN R. LIGON, Vice Chair.
Sinclair Ref. Co.
901 Fair Bldg.
Ft. Worth, Texas

JOHN L. POOL, Sec.-Treas.
Magnolia Pipe Line Co.
618 Magnolia Bldg., Box 900
Dallas, Texas

N. H. SIMPSON, Asst. Sec.-Treas.
Consol. Vultee Aircraft Corp.
Grants Lane
Ft. Worth, Texas

• Corpus Christi Section

JOHN G. CAMPBELL, Chairman
Box 1913,
Corpus Christi, Texas

BUFORD P. LEDBETTER, Vice-Chair.
Gas Department, City of
Corpus Christi, Texas

THOMAS S. MOFFAT, Sec.-Treas.
Southern Alkali Corp.,
Lawrence Drive,
Corpus Christi, Texas

• Permian Basin Section

AARON GENSBERG, Chairman
Gulf Oil Corp.,
Drawer 4232
Odessa, Texas

H. D. MURRAY, Vice-Chair.
The Texas Co.,
Box 1270
Midland, Texas

ROY H. ZUEFELDT, Sec.-Treas.
The Texas Co.,
P. O. Box 903,
Jal, New Mexico

• Sabine-Neches Section

M. A. FURTH, Chairman
Pure Oil Company,
Nederland, Texas

D. L. BURNS, Vice-Chair.
Gulf Oil Corp.,
Box 701,
Port Arthur, Texas

R. S. FREEMAN, Sec.-Treas.
Tutwiler Refinery,
Cities Serv. Ref. Corp.,
Lake Charles, La.

(Continued Next Page)

Directory of NACE REGIONAL and SECTIONAL OFFICERS

WESTERN REGION

J. C. DIETZE, Director
Dept. of Water and Power,
City of Los Angeles,
141 South Martel Avenue,
Los Angeles, California

DAVID T. JONES, Chairman
The Pacific Tel. & Tel. Co.,
4364 Farmdale Ave.,
North Hollywood, Cal.

L. L. WHITENECK, Vice-Chair.
Long Beach Harbor Dept.,
1333 El Embarcadero,
Long Beach 7, Cal.

W. M. SCHILLING, Sec.-Treas.
Southern Counties Gas Co.,
4818 Beck Ave.,
Bell, Cal.

• San Francisco Bay Area Section

ARTHUR E. STORM, Chairman
Tide Water Assoc. Oil Co.
Associated, Cal.

R. J. KING, Vice-Chairman
Standard Oil Co. of Cal.

WILLIAM R. STAPLES, Sec.-Treas.
Carpenter Steel Co.,
24 California St.,
San Francisco, Cal.

• Salt Lake Section

HARRY R. BROUGH, Chairman
Mountain Fuel Supply Co.
36 South State St.,
Salt Lake City, Utah

GEORGE R. HILL, Vice-Chair.
3725 South 11th East St.,
Salt Lake City, Utah

JOHN W. COX, Sec.-Treas.
Pipe Line Division,
Utah Oil Refining Co.,
Utah Oil Building,
Salt Lake City, Utah

• Los Angeles Section

Temporary Officer

DAVID T. JONES, Chairman
The Pacific Tel. & Tel. Co.,
4364 Farmdale Ave.,
North Hollywood, Cal.

NACE MEMBERS

IF You Change Addresses

IF You Change Company Affiliation

IF You Change Positions

Please notify the Central Office NACE, 919 Milam Building, Houston 2, Texas, so that you will get CORROSION without delay and that association records can be kept abreast of your progress.

THANKS!

Directory of Officers
TECHNICAL PRACTICES COMMITTEE

M. G. FONTANA, Chairman
The Ohio State University,
Columbus 10, Ohio

(Chairmen of all TP sub-committees listed below are members of the full committee.)

TP-1 CORROSION OF OIL AND GAS WELL EQUIPMENT (Formerly Condensate Well Corrosion)

TED S. ZAJAC, Chairman.
Shell Oil Corp., P. O. Box 2099,
Houston, Texas

TP-1A Pacific Coast. E. O. Kartinen, Chairman. Signal Oil & Gas Co., 811 W. Seventh St., Los Angeles 55, Cal.

TP-1B Condensate Well Corrosion. R. C. Buchan, Chairman. Humble Oil & Ref. Co., Houston, Texas.

TP-1C Sweet Oil Well Corrosion. H. L. Bilhartz, Chairman. Atlantic Refining Co., Dallas, Texas.

TP-1D Sour Oil Well Corrosion. H. D. Murray, Chairman. Cren-Ray Plastic Prod. Co., Midland, Texas.

TP-1E Bi-Metallic Galvanic Corrosion in Oil and Gas Wells. W. F. Rogers, Chairman. Gulf Oil Corp., Drawer 2100, Houston, Texas.

TP-1F Metallurgy—Oil and Gas Well Equipment. V. V. Kendall, Chairman. National Tube Co., Box 266, Pittsburgh, Pa.

TP-2 GALVANIC ANODES FOR CATHODIC PROTECTION

WALTER P. NOSER, Chairman.
Humble Pipe Line Co., Drawer 2220,
Houston, Texas

TP-3 ANODES FOR IMPRESSED CURRENTS

DONALD H. BOND, Chairman.
The Texas Pipe Line Company,
P. O. Box 2332, Houston 1, Texas

TP-4 MINIMUM CURRENT REQUIREMENTS FOR CATHODIC PROTECTION

TP-5 CORROSION PROBLEMS IN PROCESSING AND HANDLING CHEMICALS

MARS G. FONTANA, Chairman.
The Ohio State University,
Columbus 10, Ohio

TP-6 PROTECTIVE COATINGS

KENNETH TATOR, Chairman.
Consulting Engineer, Montour St.
Extension, Coraopolis, Pa.

TP-6A Organic Coatings and Linings for Resistance to Chemical Corrosion. Kenneth Tator, Chairman.

TP-6B Protective Coatings for Resistance to Atmospheric Corrosion. G. G. Sward, Chairman. National Paint, Varnish & Lacquer Ass'n., 1500 Rhode Island Ave., N.W., Washington, D. C.

TP-6C Protective Coatings for Resistance to Marine Corrosion. Raymond P. Devoluy, Chairman. G. A. Woolsey Paint & Color Co., 229 E. 42nd St., New York 17, N. Y.

TP-6D Pipe Line Coatings. (Chairman not appointed).

TP-6E Protective Coatings in Petroleum Production. (Chairman not appointed).

TP-6F Protective Coatings in the Food Industry. G. W. Seagren, Chairman. The Mellon Institute, Pittsburgh, Pa.

TP-6G Surface Preparation for Organic Coatings. A. J. Liebman, Chairman. Dravo Corp., Dravo Building, Pittsburgh 22, Pa.

TP-6H Glass and Vitreous Enamel Linings. G. H. McIntyre, Chairman. Ferro-Enamel Corp., Harvard & 56th St., Cleveland 5, Ohio.

TP-6I Metallic Coatings. (Chairman not appointed).

TP-6J Standards. G. G. Sward, Chairman.

EX-OFFICIO MEMBERS

R. B. MEARS
VANCE N. JENKINS
A. B. CAMPBELL

TP-7 MATERIALS FOR USE AT HIGH TEMPERATURES

M. A. SCHEIL, Chairman.
Director Metallurgical Research,
A. O. Smith Corporation,
Milwaukee, Wisconsin

TP-8 CORROSION BY WATERS

V. V. KENDALL, Chairman.
National Tube Company, Frick
Building, Pittsburgh 30, Pennsylvania

TP-9 CORROSION INHIBITORS

A. WACHTER, Chairman.
Shell Development Company, 4560
Horton Street, Emeryville 8, California

TP-10 CORROSION FATIGUE

V. V. KENDALL, Chairman.
National Tube Company, Frick
Building, Pittsburgh 30, Pennsylvania

TP-11 IDENTIFICATION OF CORROSION PRODUCTS

C. M. SCHWARTZ, Chairman.
Battelle Memorial Institute, 505 King
Avenue, Columbus 1, Ohio

TP-12 EFFECT OF ELECTRICAL GROUNDING ON CORROSION

H. L. HAMILTON, Chairman.
Keystone Pipe Line Company,
260 South Broad Street,
Philadelphia 1, Pennsylvania

TP-13 ANNUAL LOSSES DUE TO CORROSION

K. G. COMPTON, Chairman.
Murray Hill, New Jersey,
Bell Telephone Laboratories
Murray Hill, New Jersey

TP-14 INSTRUMENTS FOR CORROSION MEASUREMENTS

RAYMOND F. HADLEY, Chairman.
Susquehanna Pipe Line Co., 1608
Walnut Street, Philadelphia 3, Pa.

TP-15 CORROSION CONTROL IN THE TRANSPORTATION INDUSTRY

MERRITT A. WILLIAMSON, Chairman.
Pullman Standard Car Mfg. Co.,
79 E. Adams, Chicago, Illinois

COPIES OF CORRESPONDENCE

to and from subdivisions of NACE Technical Practices Committee should be sent to A. B. Campbell, Executive Secretary, 919 Milam Bldg., Houston 2, Texas, so they may be filed in the permanent record of committee activities.

COROMAT

Field tested, this new underground pipe wrap made by the Owens-Corning Fiberglas Corp., has shown up to 300% greater tensile strength in application than other wraps. This means the practical utilization of the longer 1200 foot rolls at higher wrapping speeds without time consuming delays due to breakage. COROMAT is available in widths from 2 to 36 inches and in 75 to 1200 foot lengths. Price $1.18 per square in carload lots of 8000 squares or more . . . $1.50 per square LCL quantities . . . all prices FOB destination.

GLASFAB

Manufactured by the Lexington Supply Company, GLASFAB, the new hydrocarbon thermoplastic impregnate Fiberglas cloth is impervious to moisture and heat and has a high tensile strength of 92 lbs. per inch. Soft, pliable and non-irritating to the hands, GLASFAB is widely used for hand-wrapping "hot spots," field joints, field repairs and for machine wrapping river crossings and "hot lines." GLASFAB is supplied in continuous rolls of 75, 400, 800 and 1000 ft. lengths.

KAPCO ROCK SHIELD

KAPCO Rock Shield, a newly developed protective shield for pipe and pipe coating was recently subjected to vigorous tests in the rocky terrain of West Virginia. Dense, limestone rocks of varying sizes were dropped from a height of five feet directly on the shield. The electronic detector showed no holidays in the coating following these tests. This new protective shield eliminates the need for padding the ditch under rocky conditions and has also been used with a high degree of success at river and road crossings, padding under river weights, pipe anchors and elsewhere where the coating is subject to damage in handling. ROCK SHIELD is available for early delivery in a Midwestern package which includes strapping, ratchet strapping tool and aluminum seals.

* Manufactured exclusively by Keystone Asphalt Products, Chicago, Ill. Division of American-Marietta Co.

For prompt delivery Midwestern maintains warehouse stocks in Tulsa, Oklahoma City, Houston, Kansas City and Newark, Ohio

WRITE MIDWESTERN FOR MORE DETAILED INFORMATION

MIDWESTERN ENGINE & EQUIPMENT CO., INC.

105 N. Boulder, TULSA, OKLAHOMA — Phone 3-4113
15 S. W. 29th St., OKLAHOMA CITY, OKLAHOMA — Phone 2-2527

HOUSTON, TEX. — D. E. HUGHES — 5030 Arvilla Lane — Olive 5-1095

PITTSBURGH, PA. — JOHN R. WILSON — 555 McCulley, McKeesport, Pa. — MCK 2-5461

SHREVEPORT, LA. — TOM L. HOLCOMBE — Box 1306 — 7-0241

ALBUQUERQUE, N. M. — IRA B. BRINER — Box 984 — 2-7598

Just what is meant by

STAINLESS

?

Some 30 alloy steels, each identified by its American Iron and Steel Institute number . . . able to thwart attacks by chemicals and atmospheres over a wide range of concentrations, pressures and temperatures...carry the family name "Stainless."

The addition of chromium in excess of 11% to steel provides, according to most generally accepted theory, a thin, adhering self-healing oxide film that protects the underlying metal. The result is a series of alloys highly resistant to corrosion and tarnishing in a wide variety of corrosive media.

Six per cent or more of nickel when added to chromium stainless steels produces a series of alloys of improved corrosion resistance known as the austenitic chromium-nickel stainless steels. Recognition by industry of this improvement is indicated by the fact that approximately two-thirds of all stainless steel tonnage produced is of the chromium-nickel type.

In the annealed condition austenitic chromium-nickel stainless steels are strong, tough, ductile and pliable. When cold-worked they are effectively strengthened and hardened; a tensile strength in excess of 200,000 p.s.i. is easily developed. Annealed, and even in the cold-worked condition, they are adaptable to many forming operations. In all conditions they are readily weldable.

At elevated temperatures, austenitic chromium-nickel stainless steels are distinguished by their strength and outstanding resistance to oxidation. At temperatures down to −300° F. they retain their toughness and unusual strength.

Other elements are sometimes added to give specific properties: to improve machinability, enhance scaling resistance, improve resistance to corrosion in specific, difficult cases.

Leading steel companies produce austenitic chromium-nickel stainless steels in all commercial forms. A list of sources of supply will be furnished on request.

EMBLEM OF INCO SERVICE
TRADE MARK

Over the years, International Nickel has accumulated a fund of useful information on the properties, treatment, fabrication and performance of engineering alloy steels, stainless steels, cast irons, brasses, bronzes, nickel silver, cupro-nickel and other alloys containing nickel. This information is yours for the asking. Write for "List A" of available publications.

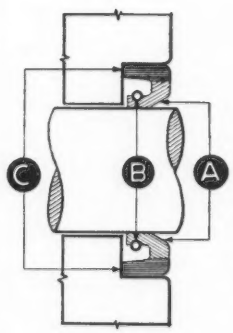
THE INTERNATIONAL NICKEL COMPANY, INC. 67 WALL STREET NEW YORK 5, N. Y.

TWIST IT . . . squeeze it . . . drop it . . . hammer it—the new one-piece concentric molded J-M Clipper Seal has plenty of give and take to help it stand up in service.

This flexibility has its advantages. The Clipper Seal's hard, tough outer heel, for example, is resilient enough to conform even to a slightly out of round cavity. Yet the soft, pliable *inner* lip always maintains a light, but positive sealing pressure on the shaft, with minimum wear on the seal.

The simple design of Clipper Seals also assures quick, easy installation, and permits removal without damage so that the seal may be used again. And because Clipper Seals are entirely non-metallic, they eliminate any possibility of electrolysis or corrosion.

Clipper Seals are made in both split and endless types . . . are available for shafts in sizes from ¼" I.D. up to 68" O.D. They are for sealing against oil, grease, water, coolants at operating temperatures up to 450°F. Write for folder PK-31A to Johns-Manville, Box 290, New York 16, N. Y.



Here's how *Clipper Seal* works:

The lip (A) is held in light but firm contact with the shaft by means of a specially designed garter spring (B). Pressure on shaft is carefully pre-determined to minimize wear, yet effectively seal against leakage. The heel (C) provides a press fit in the cavity, assuring a tight lubricant-retaining seal at this point also. This design is readily varied to meet special conditions.

Johns-Manville **PACKINGS & GASKETS**

Here's how Threshold Treatment with Calgon* controls corrosion in water systems

Calgon is strongly adsorbed on all metals and metallic oxides, especially iron and iron oxide. It controls corrosion by forming a sub-microscopic protective film over all metal surfaces in the water system, thereby insulating them from the oxygen and other corrosive elements of the water.

This film is effective at all pH values above 5.0. In fact, pH values below 7.0 are usually preferable because better control over tuberculation and pitting is obtained in this range.

The only evidence of the film on a polished metal surface is a multicolored iridescence. The film does not build upon itself and in no way impedes the flow of water.

For more detailed information on the use of Calgon to control corrosion, fill out and mail the coupon below, or write us concerning any specific problem in which you are interested.

*T.M. Reg. U.S. Pat. Off.

Hagan Corporation
Hagan Building, Pittsburgh 30, Pennsylvania

Please send me your bulletin, "Calgon Controls Corrosion."

NAME.....

POSITION.....

STREET AND NUMBER.....

CITY.....ZONE.....STATE.....

HAGAN HALL BUROMIN CALGON

calgon, inc.

A SUBSIDIARY OF HAGAN CORPORATION

HAGAN BUILDING PITTSBURGH 30, PA.

THE NATIONAL ASSOCIATION OF CORROSION ENGINEERS

is a non-profit, scientific and research association of individuals and companies concerned with corrosion or interested in it, whose objects are:

(a) To promote the prevention of corrosion, thereby curtailing economic waste and conserving natural resources.

(b) To provide forums and media through which experiences with corrosion and its prevention may be reported, discussed and published for the common good.

(c) To encourage special study and research to determine the fundamental causes of corrosion, and to develop new or improved techniques for its prevention.

(d) To correlate study and research on corrosion problems among technical associations to reduce duplication and increase efficiency.

(e) To promote standardization of terminology, techniques, equipment and design in corrosion control.

(f) To contribute to industrial and public safety by promoting the prevention of corrosion as a cause of accidents.

(g) To foster cooperation between individual operators of metallic plant and structures in the joint solution of common corrosion problems.

(h) To invite a wide diversity of membership, thereby insuring reciprocal benefits between industries and governmental groups as well as between individuals and corporations.

It is an incorporated association without capital stock, chartered under the laws of Texas. Its affairs are governed by a Board of Directors, elected by the general membership. Officers are nominated by (1) the Board of Directors, or (2) a quorum of at least 25 members, and elected by the membership.

Inquiries regarding membership, and all general correspondence should be directed to the Executive Secretary at the administrative headquarters of the National Association of Corrosion Engineers at 919 Milam Building, 803 Texas Avenue, Houston 2, Texas.

Officers, 1949-50

President.....R. B. MEARS
Pittsburgh, Pa.

Vice-President.....VANCE N. JENKINS
Wilmington, Cal.

Treasurer.....O. C. MUDD
Houston, Texas

Executive Secretary.....A. B. CAMPBELL
919 Milam Building
Houston 2, Texas

Directors

President

R. B. MEARS.....194
Carnegie-Illinois Steel Corporation, Pittsburgh,

Vice President

VANCE N. JENKINS.....194
Union Oil Company of Cal., Wilmington, Cal.

Treasurer

O. C. MUDD.....194
Shell Pipe Line Corp., Houston, Texas

Representing Active Membership

PAUL W. BACHMAN.....194
Davison Chemical Corp., Baltimore, Md.

L. J. GORMAN.....194
Consolidated Edison Co. of New York, Inc., New York, N. Y.

MAYNARD H. JACKSON.....194
Middle West Coating & Supply, Tulsa, Okla.

Representing Corporate Membership

D. C. GLASS.....194
Pure Oil Company, Chicago, Ill.

WARD R. MYERS.....194
E. I. duPont de Nemours & Co., Inc., Wilmington, Del.

JOHN M. PEARSON.....194
Sun Oil Company, Philadelphia, Pa.

Representing Associate Membership

E. D. VERINK, JR.....194
Aluminum Co. of America, New Kensington, Pa.

D. E. STEARNS.....194
The D. E. Stearns Co., Shreveport, La.

TOM L. HOLCOMBE.....194
Holcombe & Stearns, Inc., Shreveport, La.

Representing Regional Divisions

ROBERT H. LYNCH.....North E
Keystone Pipe Line Co., Philadelphia, Pa.

N. E. BERRY.....North Cent
Servel, Inc., Evansville, Ind.

L. F. SCHERER.....South Cent
Texas Pipe Line Co., Houston, Texas

IRWIN C. DIETZE.....Weste
Dept. of Water & Power, City of Los Angeles, Cal

J. T. MACKENZIE.....South E
American Cast Iron Pipe Co., Birmingham, Ala.

Directors Ex Officio

F. L. LAQUE, Past President, 1949-50
The International Nickel Co., Inc., New York, N.

E. P. NOPPEL, Chairman
Policy and Planning Committee
Ebasco Services, Inc., New York, N. Y.

MARS G. FONTANA, Chairman
Technical Practices Committee
Ohio State University, Columbus, Ohio

IVY M. PARKER, Chairman
Publication Committee
Plantation Pipe Line Co., Bremen, Ga.

L. A. BALDWIN, Chairman
Regional Management Committee
Johns-Manville Sales Corp., New York, N. Y.

Oil Can Control Wear*

By R. E. JEFFREY, JR.* and J. M. PLANTFEBER*

Abstract

A new development in engine lubricants has demonstrated that oil can control wear, where that wear is largely due to corrosion. Corrosion of cylinder walls and rings has long been known to be a factor in engine wear, but only a minor one. Therefore, little was done about it from the oil point of view until recently, development being aimed at the recognized major problems of alloy bearing corrosion, ring sticking and engine deposits.

A thorough study of engine wear has been undertaken during the last few years, to determine what could be done to minimize wear through engine oil development. The effect of the corrosive action of combustion products was found to be great in the case of certain high speed Diesel engine applications, particularly. Operating conditions and the fuel used were found to be important factors in those applications. Stationary engine operation with a given fuel is usually much more severe than operation of the same engine in a vehicle. It has been found that while fuels relatively high in sulfur are associated with high wear rates, there are many operating conditions where fuels relatively low in sulfur are associated with high wear as well. Where corrosive wear conditions prevail, Heavy Duty Type oils were found to offer but little aid in wear reduction.

A new engine lubricating oil has been developed which has been found to reduce wear to as much as one-tenth of that usually found in certain Diesel engine applications. Repeated field service tests in marine and stationary engines have confirmed this. In addition, significant reduction in engine deposits has been found with the new lubricant. In high specific output Diesel engines where ring sticking was a problem with Heavy Duty Type oils, the new lubricant has been found to give excellent results.

Because of the great demand for Diesel fuel during the last few years, it has been necessary to use components higher in sulfur in order to provide the quantities required. The development of the new lubricant is therefore particularly timely. It holds definite promise of vastly improved operation for pipe line pumping engines where the fuel used is the crude oil pumped through the line. Tests in one make of engine have been completed successfully using a heavy (25° API gravity) crude oil of 2.17 percent sulfur. These exploratory tests of short duration were sufficiently favorable that serious consideration can be given to the use of heavy fuels on a commercial basis in this engine if the new lubricant is used.

WEAR IN INTERNAL combustion engines has been thought for many years to be principally due to abrasion, whether from metal-to-metal contact between ring and cylinder wall, the aspiration of dust into the engine, or other mechanical means. Although it had been known for some time that corrosion had a part in the wear phenomenon, it played only a minor part in the general operational picture in the older slow speed engines and therefore little was done through oil development to offset its effects.

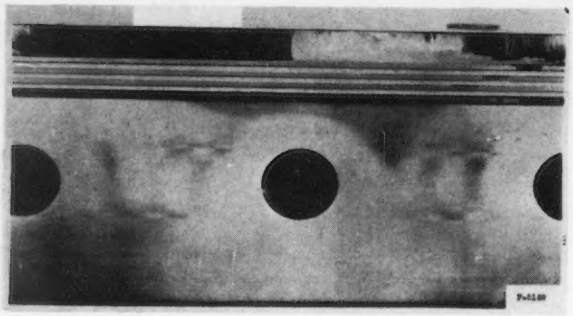
The development of engine lubricants in the oil industry during the last fifteen years had been directed toward the solution of the recognized major problems of alloy bearing corrosion, ring sticking, and engine deposits. Detergent oils, non-corrosive to alloy bearings, came out of this broad activity and established a major class of engine oils. These lubricants were described by the Ordnance Department in U. S. Army Specification 2-104B and by the American Petroleum Institute in its definition of "Heavy Duty Type" oils.

With the advent of these oils, great strides were made in improving the operation of high speed Diesel engines. Intensive research, increased skill in oil compounding, and comprehensive field studies have improved the performance of these oils still further, with the result that the modern Heavy Duty Type oils give excellent performance over a broad range of operating conditions. In some engines, however, H. D. type oils have given disappointing results. High piston ring and cylinder wear and premature piston fouling with ring sticking are observed and unduly frequent overhauls are required. The operating conditions producing these undesirable effects vary, depending upon the combination involved of such factors as thermal loading, heat transfer to the water, and fuel properties including volatility, ignition quality, and sulfur content.

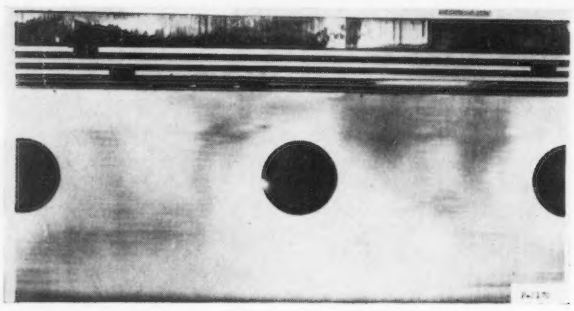
Corrosive wear has been found to be a large factor in certain Diesel engine applications. It has been found further that the corrosive effect of combustion products can be overcome where properly selected additives are present in the lubricating oil film. In short, oil can control wear in those instances where corrosion plays a heavy part.

Nearly five years ago, reports began to come in concerning serious wear and engine fouling difficulties which were being experienced with certain engine applications in marine service. These engines usually were operating under moderate loads and at relatively low temperatures using Heavy Duty Type oils. Further investigation showed that these difficulties were not confined to engines in marine service, but were prevalent also in many stationary engines running under relatively constant operating conditions at higher loads and high temperatures. Usually the same engines in vehicle service where load and speed fluctuate were not subject to these

★A paper presented at the Fifth Annual Conference, National Association of Corrosion Engineers, Cincinnati, Ohio, April 11-14, 1949.
* Shell Oil Company, San Francisco, Calif.

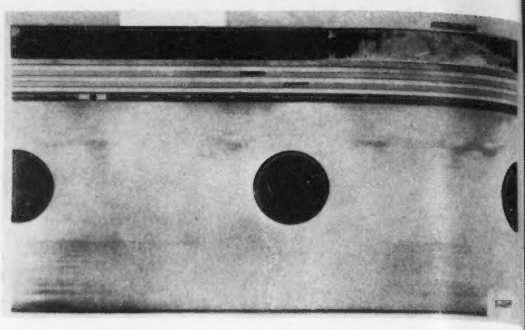


P-5169—Piston after operation with Special Oil.
Ring wear (top ring) .011" gap increase
Liner wear, avg. .0057"

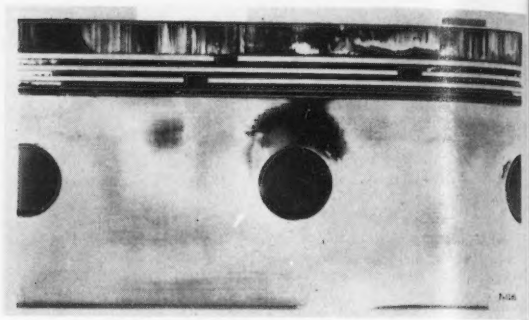


P-5170—Piston after operation with Reference Oil.
Ring wear (top ring) .050" gap increase
Liner wear, avg. .0077"

Figure 1—CRC L-1 test with one percent sulfur fuel and low (100° F.) coolant temperature.



P-5167—Piston after operation with Special Oil.
Ring wear (top ring) .009" gap increase
Liner wear, avg. .0009"



P-5168—Piston after operation with Reference Oil.
Ring wear (top ring) .028" gap increase
Liner wear, avg. .0019"

Figure 2—CRC L-1 test with one percent sulfur fuel and normal (175° F.) coolant temperature.

difficulties. No definite pattern could be established because engines running under seemingly identical conditions showed wide differences in rate of wear and fouling. Unsatisfactory results were obtained with low as well as high sulfur fuels, but, under the same conditions of operation, high sulfur fuels aggravated the difficulties.

It was suspected that the high wear was caused by corrosion, principally because the usual abrasive causes of high wear, such as dust consumption, etc., were absent. It was also suspected that the engine fouling difficulties were caused by the action of corrosive combustion products. Laboratory engine tests tended to confirm this and it was found that wear and deposits were affected by adjustment of engine operating conditions and fuel properties.

An extensive research program had been instituted a number of years before this, directed toward the development of a Heavy Duty Type oil of improved detergency and low wear properties. It was found that these improvements could be achieved to an unprecedented degree. For example, it was found in the operation of laboratory fuel testing engines that Heavy Duty Type oils gave improvement in engine fouling over that obtained with straight mineral oils, but engine deposits still limited the operating time between overhauls. An oil which departed radically from conventional compounding methods was tried with outstanding success. Engine cleanliness was excellent and ring and groove deposits were nil. In view of these results an entirely new concept of compounding oils for internal combustion engines was developed and an extensive study of new formulations was started.

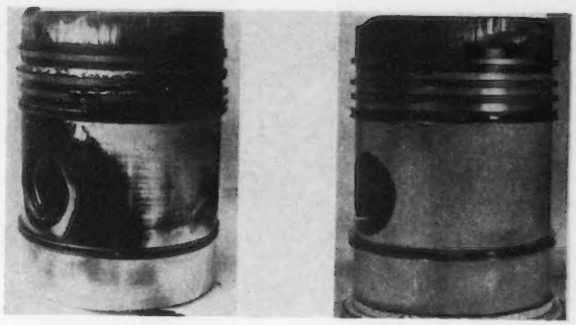
Indications were found of substantial reduction in wear under operating conditions where corrosive combustion products could be most effective. This was demonstrated in full scale, single cylinder laboratory test engines used for evaluating engine oils. Tests were run with the experimental oil and a Reference Oil (a Heavy Duty Type oil) at cooling water temperatures of 100° F and 175° F, using a fuel of 1 per cent sulfur in all cases. The wear data and the piston conditions are presented in Figures 1 and 2. As Figure 1 indicates, the top ring gap increase with the experimental oil is approximately one-fifth that when the Reference Oil was used. Liner wear was reduced, although not as drastically. Figure 2, representing the results obtained at 175° F coolant temperature, shows that the top ring gap increase with the experimental oil was about one-third that obtained with the Reference Oil. Liner wear was reduced by one-half.

To go back to reports from the field of high wear and excessive engine deposits, it was felt these problems could be reduced in the direction of normal experience through the use of a suitable lubricant based on the above findings. A Special Oil of high

additive content, suitably balanced, was developed and a field test was arranged in a medium speed Diesel engine used for irrigation purposes at Santa Ana, California. Previous experience with this engine showed that it could not finish a pumping season (about 3000 hours), but needed an overhaul after each 1000-1500 hours of operation. A 1350-hour run on a Heavy Duty Type oil of good quality and a Diesel fuel containing about 0.7 per cent sulfur resulted in an averageg wear rate of 0.017-inch per 1000 hours, stuck piston rings and a generally very dirty engine. The engine was overhauled and was operated for the first 470 hours on the same Heavy Duty Type oil before the Special Oil was put into the crankcase. The engine was inspected after an additional 1094 hours. The average wear rate was reduced to 0.0036 in. per 1000 hours, all rings were free and piston lacquer showed signs of being reduced. It was decided to repeat the test, again using the same fuel and this time the engine operated a full pumping season (3172 hours) on the new oil. Inspection revealed that the wear rate was reduced still further to the low value of 0.0005-inch per 1000 hours, the piston skirts were free of deposits, the ring lands and grooves had only traces of deposits, while the oil rings were 100 per cent open. These results proved in a preliminary way that the high wear and engine fouling difficulties experienced under some operating conditions could be alleviated by the use of this Special Oil. Pistons from these two tests are shown in Figure 3.

The field testing of the Special Oil was then expanded to include a variety of models and operating conditions. Three types of service which were known to give unsatisfactory or borderline results were selected as follows:

1) Stationary pumping and drilling units operating at low and high load factors under constant and variable conditions of temperature, speed and load.
2) Marine generator sets operating at a medium load factor under varied conditions of load and temperature, but at a constant speed.



A
1564 hours total
470 hours conventional H.D. Oil
1094 hours Special Oil
0.8% sulfur fuel
Cylinder wear 0.0036-inch/1000 hr.
In previous test conventional H.D. Oil:
Cylinder wear 0.017-in./1000 hr.

B
3172 hours
Special Oil
0.8% sulfur fuel
Cylinder wear 0.0005-in./1000 hr.

Figure 3—Piston with consecutive runs in a stationary Diesel pumping engine.

3) A marine propulsion unit operating under intermittent high load conditions with corresponding variations in temperature and speed.

The fuels used in the tests were those normally used by the owners of the engines and represented commercially available products. Each engine was carefully inspected prior to the test, so that the influence of the Special Oil could be evaluated properly. It was observed that the lubricants used prior to the start of the tests were inadequate to provide satisfactory performance. New pistons, rings and liners were installed in all engines. The results of the tests are shown in Figures 4 to 8. The results obtained previously with various Heavy Duty Type oils are shown also.

A comparison of the average cylinder liner wear is presented graphically in Figure 4. The improvement obtained is striking in each instance. The photos, Figure 5 to Figure 8 inclusive, show that the improvement in engine cleanliness with the Special Oil is

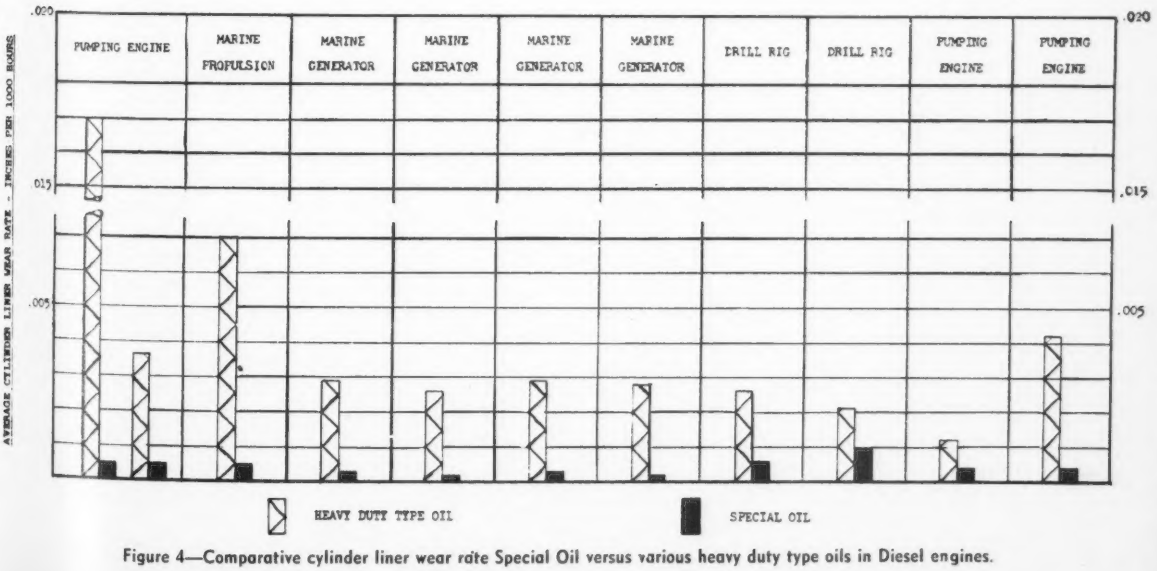
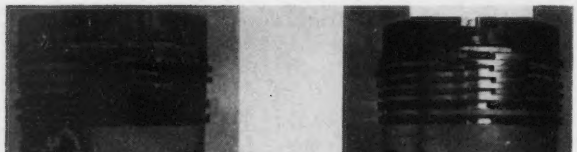


Figure 4—Comparative cylinder liner wear rate Special Oil versus various heavy duty type oils in Diesel engines.

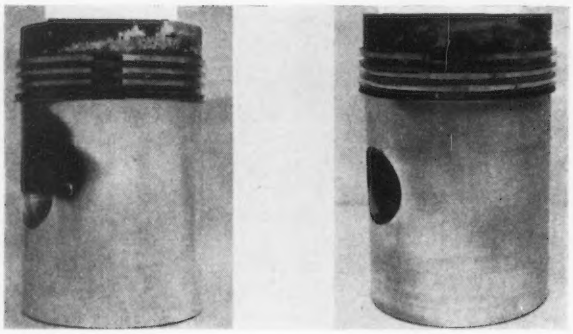


A B

1032 hours conventional H.D. Oil
0.34% sulfur fuel
Cylinder wear 0.007-inch/1000 hr.

1400 hours Special Oil
0.34-0.38% sulfur fuel
Cylinder wear 0.0005-inch/1000 hr.

Figure 5—Pistons from marine propulsion engine.



A B

2043 hours conventional H.D. Oil
0.75-1.2% sulfur fuel
Cylinder wear 0.0026-inch/1000 hr.

3676 hours Special Oil
0.75-1.2% sulfur fuel
Cylinder wear 0.0002-inch/1000 hr.

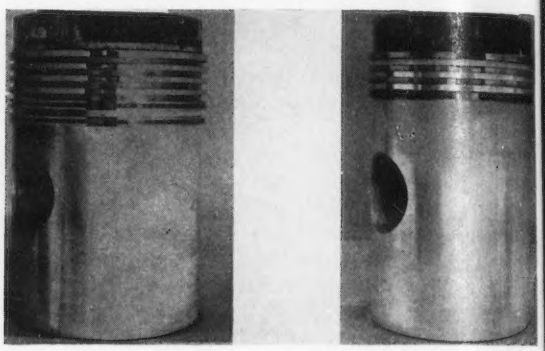
Figure 6—Pistons from marine generator engine.

A B

Unknown hours conventional H.D. Oil
0.86% sulfur fuel
Cylinder wear 0.0026-inch/1000 hr.

1550 hours Special Oil
0.84% sulfur fuel
Cylinder wear 0.0006-inch/1000 hr.

Figure 7—Pistons from drilling rig engine.



A B

3744 hours conventional H.D. Oil
0.15% sulfur premium fuel
Cylinder wear 0.0012-inch/1000 hr.

1260 hours Special Oil
0.60% sulfur regular fuel
Cylinder wear 0.0004-inch/1000 hr.

Figure 8—Pistons from pumping engine.

consistent in all cases, even with fuels with as high as 1.2 per cent sulfur.

The following is a brief summary of these results:

1) The cylinder wear rate was materially reduced in all engines with the Special Oil. The maximum reduction is about 95 per cent and the minimum is 50 per cent.
2) The skirts of all the pistons used with the new lubricant were clean, while the ring lands had only traces of lacquer. None of the top ring grooves were completely filled. Most of the engines showed an average top ring groove deposit between 20 per cent and 40 percent filled compared to 80 per cent to 100 per cent found in the grooves of the pistons inspected before the test.
3) There was evidence during the early part of the tests that deposits were being removed by the purging action of the oil even though the crankcases were wiped down and flushed with solvent before the start of the tests. Precautionary measures, in the form of short drain periods, were taken at the beginning to minimize any possible failure due to clogged screens and filters. Screens and filters inspected at the completion of the test were clean.

The conclusions which can be drawn from these field tests are:

1) The Special Oil performs more satisfactorily with high sulfur fuels and under more severe conditions than does normal Heavy Duty Type oil.
2) Definite improvements in engine cleanliness and reduction in wear were obtained under the outlined test conditions.

The improvement in engine condition and wear obtained with the Special Oil, even where high sulfur fuels were used, is particularly interesting and useful. Because of the great demand for Diesel fuel during the last few years, it has been necessary to use components from higher sulfur crudes in order to provide the quantities required. In certain localities at the present time, because of supply and transportation reasons, conventional fuels are relatively high in sulfur. Where the use of such fuels shortens engine life, the only alternative has been to use premium quality fuels. It is now possible to digest conventional fuels successfully through the use of lubricants of the new type at a much lower cost.

An additional consideration was involved in the development of the Special Oil which may be of interest, even though it is beyond the scope of this

TABLE 1

Properties of the Test Fuels in Comparison With a No. 3 Grade Oil

SOURCE	Fuel West Texas Crude	Fuel B Arabian Crude and Residual	No. 3 Grade Fuel Oil
Gravity, °API	29.1	25.0	34
Viscosity, SUS at 100° F.	62.0	174	36.5
Sulfur, percent W	1.7	2.17	0.8
Cetane No.	35.5	43	44
Pour Point, °F.	Below—15	—10	—5
Carbon Residue, percent W	0.39	5.9	0.19 (10% Bottoms)
B. S. & W. percent V.	0.25	0.3	Trace
Ash, percent W	0.005	0.01	0.001
I. B. P., °F.	140	205	380
10 percent Rec., °F.	280	316	456
20 percent	371	.....	483
30 percent	460	.....	500
40 percent	552	.....	515
50 percent	620	.....	530
60 percent	670	.....	550
F. B. P., °F.	...	.....	675
Percent Recovered at 700° F.	62	.....	...
620° F.	...	Cracked	...
Percent Recovered at 620° F.	...	32	...

paper. The performance of Heavy Duty Type oils in some supercharged and other high specific output engines have been found to be unsatisfactory. It appeared that oils of different properties were required to handle the problem of ring sticking occasioned by higher ring belt temperatures. The application of the Special Oil to these newer engines was thoroughly investigated. The result was that the Special Oil finally developed was outstanding for high specific output engines, as well as for the reduction of corrosive wear. This oil is now recommended by several engine manufacturers for many applications. It is generally classified as a Caterpillar Superior Lubricant, Series 2.

Tests have been conducted with the Special Oil in large engines adaptable for pipe line pumping service where the fuel used is usually the crude oil pumped through the line. These tests have been run in but one make of engine so far, but show striking results in comparison with a good Heavy Duty Type oil. Two crude oils were used in separate tests, one a 29° API gravity West Texas crude of 1.7% sulfur and the other an Arabian crude of 25° API gravity and 2.17% sulfur containing a large amount of residual material. The properties of these fuels are listed in Table 1, together with those of a No. 3 grade Fuel Oil coming within the engine manufacturers' recommendations. These exploratory tests were of short duration, but the engine deposits and wear were much more favorable with the Special Oil. Serious consideration can therefore be given to the use of heavy fuels on a commercial basis in this engine if the new lubricant is used.

The possibilities of this new engine lubricant are many and it is felt that it lies in an application field relatively unexplored. Further explorations are going on in many different types of engines and service. It has been established definitely, however, that in Diesel engines operating under conditions where the corrosive action of combustion products is great, oil can control wear.

DISCUSSIONS ARE INVITED

Readers who wish to submit written information additive to articles published in CORROSION, or who wish to register differences of opinion with respect to any articles are urged to send such discussions to Dr. F. N. Alquist, Chairman, NACE Editorial Review Committee, Organic Research Laboratories, 20A Building, Dow Chemical Co., Midland, Mich. Doctor Alquist will submit such discussions to a member of the review committee, and after review and approval the discussion will be published.

The expression of opinions about or the addition of information to that contained in technical articles will advance the interests of NACE and make CORROSION more valuable to the membership.

Field Experience with Corrosion Protection Of Galvanized Steel Substation Structures★

By SIEBERT L. MILLER*

THIS PAPER is intended to relate the results of comparative "in service" tests of several materials applied to galvanized steel substation structures during a period of several years. Particular emphasis will be placed on contrasting the actual results obtained with various materials and not on why the materials acted as they did under like conditions of exposure.

Briefly, the case histories which have been selected as examples and experience gained from still others not herein described show the following:

1. Corrosion protection should be provided at an early stage before complete deterioration of the galvanizing.
2. Protective coatings should possess the following qualities:
   (a) Should adhere tightly to weathered galvanizing.
   (b) Should be adequately pigmented and possessed of proper paint consistency characteristics to cover sharp corners of structural members in one coat.
   (c) Should not fail by chipping, cracking, blistering or rapid "chalking."
   (d) Should be compounded so that the pigment is slow to settle out.
3. Excellent corrosion protection should be obtained with one coat application.

The subject of corrosion protection of galvanized steel substation structures and transmission line towers is one upon which opinions vary greatly, particularly with respect to why and when the protection should be afforded. The probable reason for this is that opinions also vary with respect to the evaluation of the galvanizing itself. We do not hold to the belief that galvanizing as a planned additional expense should, by itself, be expected to permanently maintain a structure in good condition It is, therefore, accepted as a matter of course that in time it should be given further corrosion protective treatment. As to what length of service can or should be expected before this further protection is required depends, of course, on the quality of the galvanizing job itself and on the atmospheric conditions where the structure is located. We have seen galvanizing start failing in 3 to 5 years, but on the other hand, and in many more cases, adequate protection is afforded by the galvanizing for 15 years or more.

Whatever be the time element before failure starts, and this holds for even a poor quality galvanizing job, we have concluded that for best long range economy the structure should be painted before rusting actually starts. This not only precludes the starting of the vicious rust problem but also protects the original investment in galvanizing, an ideal rust inhibitor, a most reliable and dependable protective base. (It is, of course, assumed that the justification for galvanizing is not questioned.)

Also, if the structure is painted before the galvanizing has broken down it can be done for about one-half the cost of a job started after rusting has been permitted to start. Before the galvanizing has broken down, only one coat is necessary with no cleaning work and also only one outage of equipment is required. Since the outages are most generally on Sundays or other "off hour" times, they involve overtime pay. But exclusive of the cost angle it is highly desirable to avoid taking equipment out of service as much as possible because of today's high loading of circuits. In fact it is practically impossible to take circuits out of service in many cases.

If the structure is not painted until after the galvanizing has completely broken down and rust has started over all the structure the cost will be three to four times that of the job done before deterioration of the galvanizing, depending on the extent of rusting. This, of course, is because of the additional coats and cleaning required which involve more labor, material, and outages. Also, the maintenance picture now changes entirely because of the rust. The structure will continue to deteriorate because wherever rust has once started it is generally conceded that its growth can seldom be completely stopped, but simply retarded. The paint system, whatever it may be, is definitely weakened because, where rust has been present, the coating is being attacked from the underside as well as from the outer, weather exposed surface. Also, rust may not be thoroughly covered or inhibited so that spots may develop sooner than expected in places not readily observed and may lead to dangerous pitting. Since deterioration from rust is progressive and increases in rapidity with time, it can easily reach a point where structural strength is affected or expensive repairs and replacements are required. To say the least, more frequent and more thorough inspections will be necessary which also add to the cost picture. Thorough inspections of the substation structure requires it being de-energized thus involving expense and other undesirable features mentioned previously.

You, of course, know that there are many materials available which are supposed to possess the properties for protecting galvanized steel structures whether

★ A paper delivered at the Fifth Annual Conference, National Association of Corrosion Engineers, Cincinnati, Ohio, April 11-14, 1949.

* System Supervisor Substation Maintenance, Union Electric Co. of Missouri, St. Louis, Mo.

a one-coat or two-coat system is employed. However, experience has produced results which vary widely and since accelerated weather tests are not conclusive, we decided that it would be worth while to make actual comparative "in service" tests of various products applied in exact accordance with manufacturer's recommendations and directions. This we have been doing for ten years.

One of the several materials tested gave excellent results. This is a material compounded with a highly pigmented mixture of lead suboxide and aluminum in a vehicle of linseed oil, tung oil, and driers; which we shall identify as paint "A."

This material was initially applied to the galvanized steel structure at our Baden Substation in October, 1940. The structure was erected in 1927 and at the time of painting, over 13 years after erection, the galvanizing had deteriorated to the point where slight rusting had started on the corners of some of the structural angle tension members and on the upper horizontal surfaces of some channels. Practically no rusting was evident elsewhere on these members nor on any columns, although the galvanizing was getting very thin. From past experience we considered the structure just right for painting and if any one-coat paint job would stand up this was a place to try it.

At this same time the galvanized steel structure at our Penrose station also required painting. This structure was erected in 1926, a year earlier than the one at Baden, but the galvanizing was in the same stage of deterioration. This structure was therefore also at the proper stage for trying a one-coat paint job. Since both structures are exposed to the same atmospheric conditions, and they were both at the same stage of deterioration, we decided to paint them with different materials so as to have a comparative "in service" test of two different materials.

We selected two materials both of which were highly recommended for one-coat application on structures such as these. Both structures were then painted one coat in exact accordance with the manufacturer's recommendations and directions. Also, the same care was exercised in the application of both materials because our own painting crew, in fact, the same men, in both cases did the work. Application of material was made by hand brushing.

Case I

The Baden structure was painted in October and November, 1940 with one coat of paint "A" which was applied without any spot priming. The preparatory cleaning consisted of only wire brushing since the rusting had not progressed far enough to form scale. This coating after more than 8 years service is still in good condition. Actually the structure appears now that it will not require re-painting for another two years or more. No rusting has yet started and the coating is still tight and sound.

Case II

The Penrose structure was painted in June, 1941 during ideal weather with one coat of paint "B" which is composed of a high grade aluminum pigment in a vehicle containing among other things a rust inhibitor. Here also, as in case I there was no spot priming and the preparatory cleaning consisted of only wire brushing. In less than 3 years this paint started failing by cracking, checking and even peeling and got progressively worse, of course, until it was re-painted in 1947. We found upon starting the re-painting job here at Penrose, as is often the case, that it would have been much more economical to have repainted at least a year earlier because the deterioration had gone further than we thought, requiring additional time for cleaning and spot priming. At the very best the life of type "B" material could not be considered as being longer than 4 years. Because of the poor protection during its life and waiting too long to re-paint, two coats were necessary for a large portion of the structure thus increasing the cost of the job 60%. Type "A" paint was used for this re-painting job.

"In service" tests of two other materials were started at our Page Station in 1942 and 1943. Here again, both of the materials selected were highly recommended for one or two coat application. However, in these instances the galvanizing on both structures had deteriorated a little further than in the two previous cases and we decided to apply two full coats to all rusted areas.

Rust had started on the corners of practically all of the structural angle tension members and was present in small patches here and there on the vertical surfaces of the columns as well as on the upper horizontal surfaces of structure members. The rust extended over about 30% of the total area of the latter surfaces but had not progressed far enough to materially attack the base metal nor to form scale. All of these areas were cleaned by wire brushing prior to application of the priming coat.

Case III

One of the structures was painted in 1942 with type "C" paint, composed of a zinc dust pigment in a vehicle containing a special type rust inhibitor. Application was made in exact accordance with manufacturer's directions and with the same painting crew that applied paints "A" and "B" at Baden and Penrose. All rusted areas after cleaning were spot primed with paint "C" and then the entire structure received a full coat of the same material.

This structure required re-painting in 1947 after 5 years of poor service for this material. Failure of the film came about through "chalking" action which was entirely too rapid. This chalking action started after about 2 years service and after 3 years, the paint film was so porous that rust again began forming. There never were any signs of cracking or checking and adhesion was excellent for the entire life of the film. Here again, because of poor protection, deterioration progressed more rapidly than we thought so that two full coats of type "A" paint were required in 1947.

Case IV

The other structure at Page Station was painted in 1943 with type "D" paint containing a pigment

compound on one of the leafy types of natural ferric oxide.

Here, again following recommendations to the letter, we applied a full prime coat to all rusted areas and one full finishing coat of the same material to the entire structure. Application was made by hand brushing during ideal weather conditions. At the very outset, before work started, we discovered that it was difficult to keep the pigment suspended in the vehicle. Upon learning that this was a quite natural characteristic of this material, we set up a mechanical stirring device in an attempt to keep each day's requirement properly agitated. The painters were given only a small amount of freshly stirred material at a time to avoid separation of pigment and vehicle during application. However, with all of the precautions taken in this regard it could be seen later, when the paint started failing, that a great many areas had received very little more than a coating of the vehicle.

This type "D" material started failing in about 2 years and by the third year the structure looked as bad as before the material was applied. In many places failure occurred through a film of apparent normal thickness and in others the rust re-appeared in spots where the film had been applied too thinly due to the difficulty of maintaining proper pigment suspension. There never appeared to be any "chalking off" of the film and adhesion was excellent over the entire structure.

General

Two of the foregoing examples are cases of simply applying one coat of material with no priming whatsoever while the latter two received full priming of the rusted areas before application of the final coat.

We have two other structures painted with two full coats of the type "A" paint. These structures received this treatment only 3 years ago and up to the present time the protection is sound.

Quick drying paints were not used. Types A, B and C dried fairly soon to a rather tough surface. Type D remained soft for several weeks and was applied from boatswain's chairs to eliminate need for climbing on structure.

Conclusions

We find it more economical to provide corrosion protection before the galvanizing is completely broken down. In other words, protect the galvanizing so that it may continue its effectiveness.

Excellent corrosion protection is afforded for several years with one-coat application of lead suboxide and aluminum, type "A" paint, if applied before galvanizing is completely deteriorated.

Certain other types of protective materials which have been described do not effectively protect in one or two coat application for as long as the type "A."

Some other types of materials apparently have characteristics which indicate the following undesirable qualities:

1. Poor adhesion to weathered galvanizing.
2. Lack of adequate pigmentation.
3. "Chalk off" rapidly or fail by cracking, chipping or blistering.
4. Difficulty of maintaining pigment suspension.

NACE REPRINT PRACTICE

Requests for prices on reprints of material appearing in CORROSION should be addressed to Norman Hamner, Managing Editor, National Association of Corrosion Engineers, 919 Milam Building, Houston 2, Texas. Prices usually cannot be given until after articles have appeared in CORROSION although requests for prices may be submitted at any time. Type from which technical articles are printed is kept standing for 90 days after date of issue, and reprints ordered during that interval will be from standing type. For reprints ordered after expiration of this period, write for details.

Permission to reprint articles usually is given to responsible firms and individuals who wish to have the work done themselves. NACE requires, however, that proper credit be given CORROSION at an appropriate place on all reprint material. The association also requests that reprint style closely conform to that approved by its board to be in keeping with the aims and objectives of the association and that copies of reprints made under this authority are supplied NACE for recording purposes.

Corrosion of Steel Pipe By Chlorinated Seawater at Various Velocities*

By V. B. VOLKENING*

Introduction

THE DOW CHEMICAL Company in 1940 selected a site on the Gulf Coast near the mouth of the Brazos River for the production of magnesium from seawater. The site selected near Freeport was also to include a plant for the extraction of bromine from seawater. Because of the relatively low concentrations at which these elements occur huge volumes must be handled for production of tonnage quantities.

Because seawater is one of the largest volume raw materials used at the Texas Division plant of The Dow Chemical Company, the corrosion of steel in contact with seawater is of first order importance. Second only to controlling corrosion of process lines and equipment handling seawater is the necessity of controlling bio-fouling of this equipment by the marine organisms commonly found in seawater. Together these two factors can become very costly by contributing to the amount of maintenance and shut down time necessary for replacements of corroded equipment and cleaning of fouled lines. The magnitude of this problem may be better understood if it is realized that more than 500,000,000 gallons per day of seawater are processed or used as cooling water in the various operations.

The seawater is taken from the Gulf of Mexico by means of an intake located near the Freeport harbor approximately one mile from the mouth of the old Brazos River. In order to insure against dilution with fresh water a concrete apron extends 20 feet beneath the surface and the sea water is drawn from this depth by four 90,000 gpm 54-inch axial flow pumps. Trash and small fish are filtered out by a series of three progressively smaller screen filters. Distribution is obtained throughout the plant in two open flumes one of which is approximately 2500 feet long, the other 3300 feet.

From previous experience at Wilmington, North Carolina, it was known that control of marine organisms was necessary. The literature had indicated that one half part per million of residual chlorine was sufficient for this purpose. With this as a basis, chlorination of the plant seawater was begun soon after the plant had started operating. The chlorine was added continuously in the form of 0.2% solution at the intake just downstream of the last series of filters previously mentioned. Controls were maintained by taking hourly samples approximately 200 feet downstream where the residual chlorine content of the water was determined by means of a Hellige comparator using ortho-tolidine.

Because chlorinated seawater was known to be corrosive, it was decided that a test station should be established for determining the rates of corrosion at several residual chlorine concentrations and several seawater velocities. It was also considered essential to establish definitely the minimum residual chlorine concentration necessary to prevent bio-fouling in slow moving seawater at this location. The test station was established and was operated initially November 17, 1944.

Apparatus and Procedure

The experimental chlorinated seawater corrosion test station was designed to allow for five velocities, ranging from 0.1 to 6.4 feet per second, and six residual chlorine concentrations, from 0 to 4 parts per million. How this was accomplished may be seen in Figure 1. The unchlorinated seawater entered the five runs from a 4-inch diameter header, and the volume was controlled in each by a 1-inch diameter throttling valve. Following the throttling valve each run was swaged to a 2-inch diameter Saran section into which a predetermined quantity of chlorine

★ A paper presented at the Fifth Annual Conference, National Association of Corrosion Engineers, Cincinnati, Ohio, April 11-14, 1949.

* The Dow Chemical Company, Freeport, Texas.

ABOUT THE AUTHOR. V. B. Volkening, who is in the chemical engineering department of The Dow Chemical Company at Texas Division, Freeport, Texas has been employed by Dow for ten years. The last five years his principal field has been research and development work related to proper selection of materials of construction and corrosion prevention, in the latter area principally with protective coatings. An NACE member, he also is a member of the American Chemical Society and the American Institute of Chemical Engineers. He received a BS in chemical engineering from the University of Texas in 1937.

Abstract

Corrosion rates of steel pipe in seawater were obtained for six residual chlorine concentrations ranging from 0 to 4.0 ppm at five seawater velocities from 0.1 to 6.4 feet per second. Pitting rates were accurately measured and compared with weight loss corrosion data. The minimum effective dosage of chlorine was determined for elimination of marine fouling organisms. A simple accurate method for the determination of residual chlorine in seawater is also discussed.

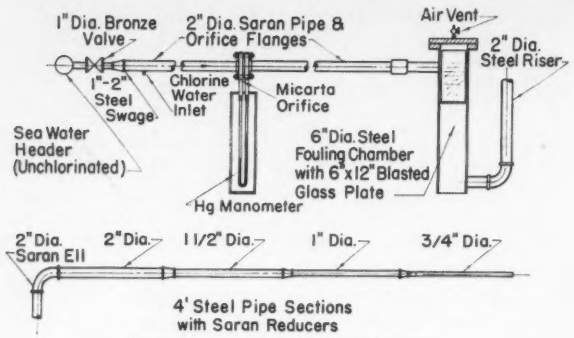


Figure 1—Diagram of typical pipe run.

water was injected. The application point of the concentrated chlorine solution was in turn followed by tapped Saran flanges containing an orifice plate, a steel fouling chamber, and the four sections of 2-inch diameter, 1½-inch diameter, 1-inch diameter and ¾-inch diameter steel pipe, respectively.

The flow rates were adjusted to 10.5 gallons per minute in each pipe run giving velocities of 1.0, 1.65, 3.9 and 6.4 feet per second in the four different diameter pipe sections and approximately 0.1 foot per second in the fouling chamber. Due to the thickness of the orifice plate and to the turbulence caused by the throttling valves and the addition of the strong chlorine water some four feet upstream the amount of seawater flowing was originally determined by displacement. In Figure 2 the completely assembled station is shown.

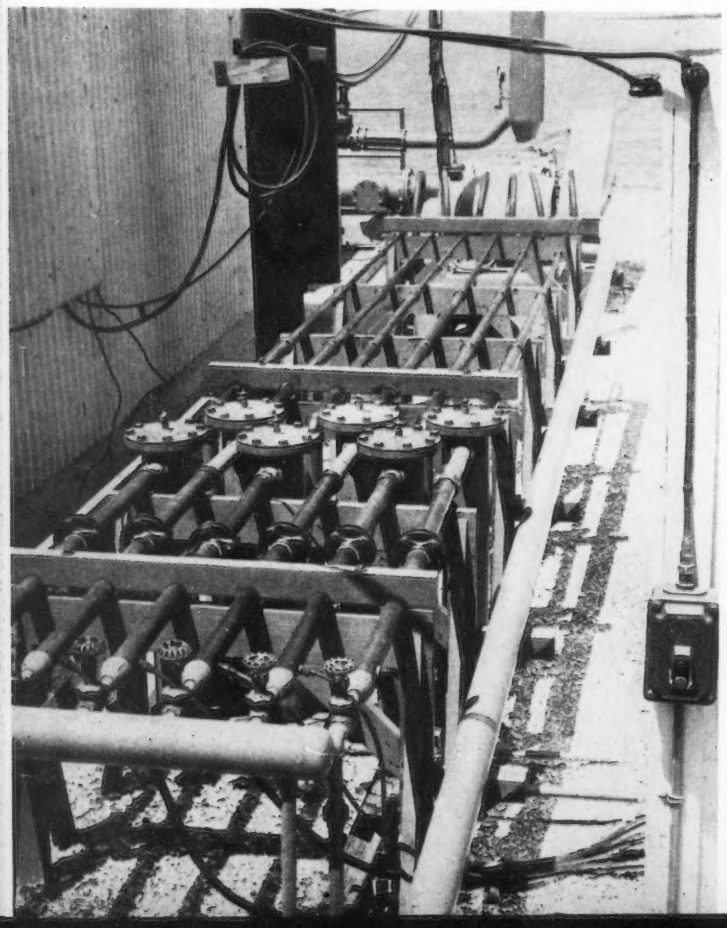


Figure 2—Completely assembled corrosion test station pipe runs.

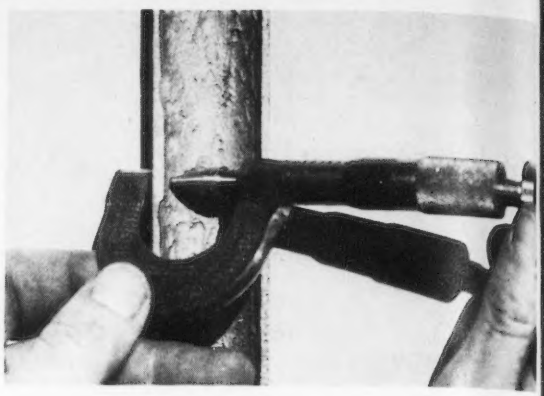


Figure 3—Measurement of pit depths.

The residual chlorine concentrations of 0.5, 1.0, 2.0 and 4.0 ppm were maintained in each of the four runs by means of four Wallace and Tiernan type M.S.P.M. chlorinators fed from standard 150-pound chlorine cylinders. The other two runs contained regularly chlorinated plant seawater and unchlorinated seawater, respectively. The amount of chlorine to each of the four controlled runs was checked twice daily by counting the bubble rate in each chlorinator. The residual chlorine concentration was determined twice weekly by a starch-iodide titration[1] and checked against a colorimetric ortho-tolidine method.

The test station was operated for 14 months. Final shut down resulted when the pipe section containing 4.0 ppm residual chlorine at a velocity of 6.4 feet per second developed a small hole near the discharge end. The station was dismantled and the pipe sections were made ready for cleaning and weighing.

Each 4-foot pipe section was cleaned with 15% inhibited hydrochloric acid. One end of the pipe section was closed by means of a cork stopper and the pipe was filled with the inhibited acid and allowed to stand 10 to 15 minutes. The spent acid was transferred to another section and fresh acid was placed in the first section and allowed to stand again for several minutes. The section was then flushed with water and cleaned out with a ramrod using a cloth swab. The sections were swabbed dry, the exterior coating removed, and then tagged and weighed to determine the overall weight loss corrosion rate. The pipe sections were originally protected on the outside by two thick coats of Bitumastic No. 50. When breaks occurred in the coating, they were touched up with this same material. It was removed from the pipe sections by chipping before they were weighed. Because of the brittleness of the coating this was an excellent method for removing it.

The pipe sections were later split longitudinally and the accumulated rust lightly sand-

blasted. A micrometer, shown in Figure 3, with a specially designed pointed ½-inch tip slipped over the spindle to allow entrance into pits as small as ⅛-inch diameter, was used to determine the pit depths. Approximately twenty measurements were made on each half pipe section. Of these the average of the deepest ten pits was taken as the average pit depth for each pipe section. The depth was determined by subtracting the remaining wall thickness from the nominal wall thickness given in the handbooks for schedule 40 standard steel pipe.

Discussion of Results

The temperatures of the seawater encountered during the 370 operating days of this experiment were as follows:

December through March.....54-57° F
April through June.....70-78° F
July and August.....82-85° F
September through November.....71-78° F
December and January.....56-58° F

These are typical for year round operations. A maximum daily average temperature of 87° F and a minimum of 46° F have been recorded here.

As shown in Table No. I, between 0.5 ppm and 1.0 ppm residual chlorine was required to control fouling at low flow rates. These results tabulated at about the midpoint of the experiment were consistent with those shown in Figure 4 which was taken at the end of the experiment. There were times when abundant growths of tubularia were present in the run containing no chlorine. There was one period from June to August when 0.5 ppm residual chlorine was sufficient to prevent fouling of any kind on the glass plate. This did occur during a period of several shut downs of sufficient duration to allow water in the fouling chambers to stagnate and allow the organisms to die. New growth was slow to form under these conditions.

TABLE I—Effect of Residual Chlorine Concentration on Fouling

Pipe Run No.	Residual Cl_2, ppm.	Condition of Fouling Plates
1	0	Very badly fouled with small barnacles, oysters, tubularia and other marine organisms.
6	0.0–0.3	More than 50 small organisms about $\frac{1}{16}$" to ½" diameter on both sides of plate. No tubularia or hard shelled organisms.
5	0.5	Less than 50 small organisms $\frac{1}{16}$" diameter.
4	1.0	No fouling.
3	2.0	No fouling.
2	4.0	No fouling.

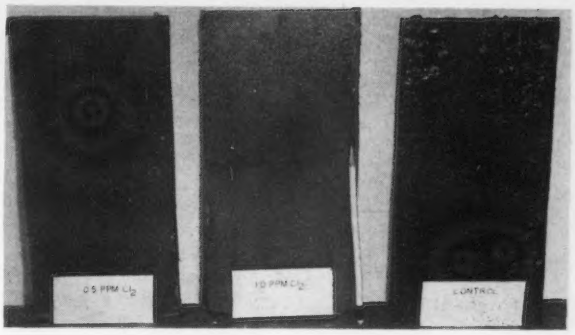


Figure 4—Ground glass fouling plates after exposure.

The corrosion data and results obtained from this experiment are shown in Table II. In general the overall weight loss corrosion rate and pitting rate increase with increasing velocity and increasing residual chlorine concentrations. Results were more erratic at the lower velocities and chlorine concentrations than those at higher velocities. Figure 5 shows the effect of velocity on the overall corrosion rate as determined by weight loss at various chlorine concentrations. With residual chlorine concentrations of 0.5 ppm velocities must be kept below 4 feet per second in order not to exceed corrosion rates of 100

TABLE II—Corrosion and Pitting Data and Results

Pipe Run No.	Pipe Dia. Inches	Velocity f.p.s.	Residual Cl_2ppm.	Pipe Init.	Weights Final	Grams Loss	Rate IPY	Pipe Wall Thickness Inches	Max. Pit Depth, Inch	Percent Pipe Wall Penetration	PITTING RESULTS	
											Average Pit Depth IPY	*Ratio:
1.....	¾"	6.4	0	1939	1827	112	0.0070	0.113	0.058	51.4	0.040	5.7
	1"	3.9	0	2966	2761	235	0.0115	0.133	0.031	23.3	0.025	2.2
	1½"	1.65	0	4900	4459	441	0.0140	0.145	0.083	57.2	0.059	4.2
	2"	1.0	0	6678	6250	428	0.0106	0.154	0.072	46.7	0.065	6.1
2.....	¾"	6.4	4	1938	1380	558	0.0348	0.113	0.113	100.0[2]	0.102	2.9
				2961[1]		565	0.0274					3.4
	1"	3.9	4	3200	2396	804	0.0394	0.133	0.105	79.0	0.093	2.4
	1½"	1.65	4	4980	4369	611	0.0195	0.145	0.140	96.6	0.110	5.6
	2"	1.0	4	6272	5997	275	0.0068	0.154	0.049	31.8	0.043	6.3
3.....	¾"	6.4	2	1938	1384	554	0.0346	0.113	0.113	100.0[3]	0.089	2.5
	1"	3.9	2	2947	2539	408	0.0200	0.133	0.133	100.0[3]	0.099	4.9
	1½"	1.65	2	4958	4418	540	0.0172	0.145	0.106	73.2	0.078	4.5
	2"	1.0	2	6640	6321	319	0.0079	0.154	0.056	36.4	0.050	6.3
4.....	¾"	6.4	1	1938	1445	493	0.0308	0.113	0.080	70.7	0.069	2.2
	1"	3.9	1	2968	2552	414	0.0203	0.133	0.072	54.1	0.060	3.0
	1½"	1.65	1	4879	4675	204	0.0065	0.145	0.043	29.7	0.032	4.9
	2"	1.0	1	6630	6414	216	0.0054	0.154	0.054	35.1	0.042	7.8
5.....	¾"	6.4	0.5	1938	1558	380	0.0237	0.113	0.083	73.5	0.062	2.6
	1"	3.9	0.5	2960	2569	391	0.0191	0.133	0.055	41.4	0.049	2.6
	1½"	1.65	0.5	4818	4489	329	0.0105	0.145	0.120	82.8	0.085	8.1
	2"	1.0	0.5	6419	6192	227	0.0056	0.154	0.045	29.2	0.037	6.6
6.....	¾"	6.4	0.0–0.3	1998	1780	218	0.0136	0.113	0.068	60.2	0.051	3.8
	1"	3.9	0.0–0.3	2963	2743	220	0.0108	0.133	0.033	24.8	0.025	2.3
	1½"	1.65	0.0–0.3	4850	4577	273	0.0087	0.145	0.085	58.6	0.079	9.1
	2"	1.0	0.0–0.3	6435	6258	177	0.0044	0.154	0.049	31.8	0.045	10.2

[1] 2961 grams is average weight of 5 other 1" ϕ pipe sections. 3200 grams believed error in original weight.
[2] Pipe section developed a small hole while in operation.
[3] Pipe section developed a pin hole when cleaned.

*RATIO: Avge. Pitting Rate / Avge. Corrosion Rate

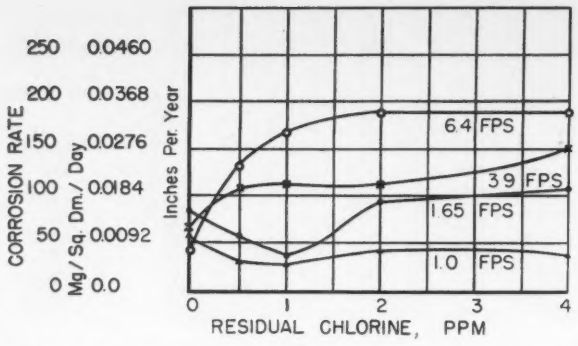


Figure 5—Effect of velocity at various chlorine concentrations on corrosion rate of steel piping.

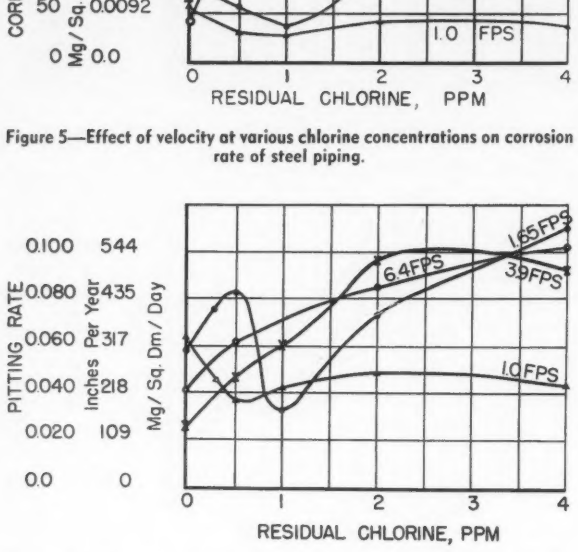


Figure 6—Effect of velocity of seawater at various residual chlorine concentrations on pitting rate of steel piping.

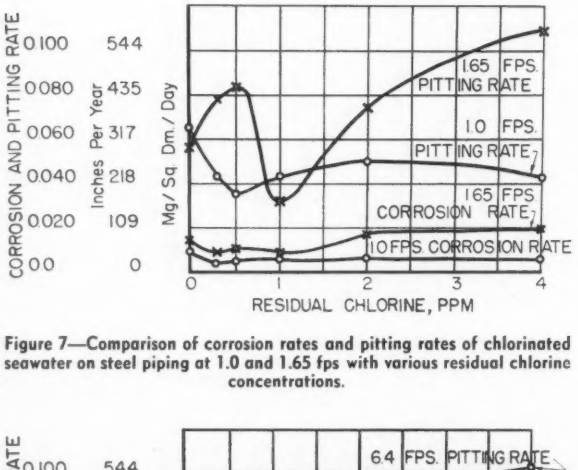


Figure 7—Comparison of corrosion rates and pitting rates of chlorinated seawater on steel piping at 1.0 and 1.65 fps with various residual chlorine concentrations.

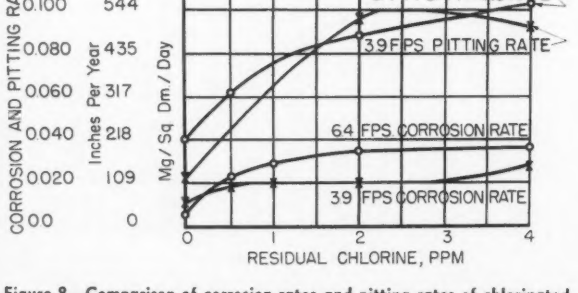


Figure 8—Comparison of corrosion rates and pitting rates of chlorinated seawater on steel piping at 3.9 and 6.4 fps with various residual chlorine concentrations.

milligrams per square decimeter per day, the rate usually considered the threshold of serious corrosion.[3]

Pitting is by far the most serious factor to be considered in the corrosion of steel piping by chlorinated seawater. Figure 6 shows the effect of pitting on steel piping. The results are less consistent than the overall weight loss corrosion rate. The ratios of penetration by pitting to penetration calculated from overall weight loss varied from as low as 2.2 at high velocities to 10.2 at low velocities. In Figure 7, the inconsistency at the lower velocities is more clearly demonstrated. It is here that the ratio of pitting to weight loss is of the order of 10. Figure 8 shows that more consistent results are obtained at the higher velocities. These are the velocities most commonly encountered in practice. It is evident that the pitting rate is the controlling factor. It was the factor which terminated this experiment.

Penetration of the pipe is found in three instances. Two of these may be seen in Figure 9, at 6.4 feet per second velocity with 2 and 4 ppm residual chlorine. This establishes the life of ¾-inch and 1-inch diameter mild steel pipe at 4 to 6 feet per second velocity containing 2 ppm residual chlorine or higher at approximately one year. Based on these data the maximum expected life of any of the pipe sections would have been slightly over four years at 3.9 feet per second carrying seawater containing from 0 to 0.3 ppm residual chlorine assuming that the pitting rate is a linear function of time.

The original weight of the 1-inch diameter pipe section containing seawater with 4.0 ppm residual chlorine seems to be in error. The corrected original weight was determined by taking the average weight of the other five 1-inch diameter pipe sections and using this value. The corrected point agrees extremely well with the rest of the data. This value is believed to be more nearly correct because the deviation of the original weight as first recorded was farther from the average for this size than the maximum deviation in any other diameter.

Corrosion rate results are in good agreement with those obtained at the Woods Hole Oceanographic Institution[3] and pitting rates of unchlorinated seawater agree fairly well with the maximum indicated in the Corrosion Handbook.[4]

Analytical Methods

The residual chlorine concentrations spoken of in this paper were determined by the starch-iodide method.[2] This method is at variance with the colorimetric determination using a Hellige comparator using a 330-D chlorine disc. The Hellige colorimetric method of analysis which depends upon the depth of color produced with an ortho tolidine solution was formerly used as a means of control in our plant. Some idea of the difference may be observed in Table No. III.

We soon began to give serious consideration to a better means of indication of the residual chlorine in our seawater lines. A simple titration by means of a 0.005 percent solution of methyl orange indicator was the answer. Now our controls are made by the same unskilled manipulators who were using the

TABLE III—Comparison of Analytical Methods Residual Chlorine, ppm

Starch-Iodide	Methyl Orange	Hellige Comparator Ortho-Tolidine 330-D Cl_2° Disc
0.2	0.2	0.1
0.6	0.7	0.2
1.05	1.20	0.5
1.6	1.7	0.7
2.05	2.05	1.2
2.20	2.20	1.3

Hellige comparators, and results are obtained comparable to those obtained by the starch-iodide method, yet not involving the skill required by the starch-iodide method. The methyl orange solution must be prepared monthly. Table III will also indicate the agreement of the methyl orange and starch-iodide methods. For reasons of greater accuracy in the low range of concentrations encountered in actual operations, the methyl orange titration is a definite improvement over the ortho-tolidine method.

Summary and Conclusions

1. Between 0.5 and 1.0 ppm residual chlorine is required to effectively prevent the attachment and growth of marine fouling organisms in mild steel piping carrying seawater at low velocities.
2. In general the corrosion rate of steel pipe, as determined by weight loss, increases with:
   a) Increasing seawater velocity.
   b) Increasing residual chlorine concentrations especially with velocities of 4 fps or above. At velocities below 4 fps results are somewhat less consistent.
3. Pitting rates agree qualitatively with the corrosion rates as determined by weight loss. Pitting rates are greater than average corrosion rates by the magnitude of 2.2, at the highest velocity (6.4 fps), to 10.2, at the lowest velocity (1.0 fps), for the same residual chlorine concentration.
4. The pitting rate of mild steel piping by unchlorinated seawater at low velocities (1.0 to 1.65 fps) is nearly twice the pitting rate at high velocities (3.9 to 6.4 fps).
5. The life of mild steel pipe in either chlorinated or unchlorinated seawater is determined by the pitting rate and not by the average corrosion rate determined by the overall weight loss for all velocities encountered in this experiment.
6. The methyl orange method of titrating for residual chlorine is an improvement in accuracy over the colorimetric determination using ortho-tolidine, especially at concentrations below 1.0 ppm.

Acknowledgement

Thanks are due to Wallace and Tiernan, Inc. for the use of their chlorinators, and to others who contributed valuable suggestions and pertinent information.

References

1. Standard Methods for the Examination of Water and Sewage, 9th Edition, 1946, pp. 92-100.
2. McKay, Robert J., and Worthington, Robert, "Corrosion Resistance of Metals and Alloys," ACS Monograph 71, Chapter IV, pp. 102-103, New York, Reinhold Publishing Corp., 1936.
3. Turner, Harry J., Jr., "The Concentrations of Chlorine and Sodium Pentachlorophenate Required for the Prevention of Fouling in Seawater Piping Systems." Interim Report No. XI for 1945 submitted by The Woods Hole Oceanographic Institution to the Bureau of Ships, U. S. Navy Department, Washington 25, D. C.
4. Uhlig, H. H., "The Corrosion Handbook," New York, John Wiley and Sons, Inc., 1948, p. 391.

DISCUSSION

By Gustave Heinemann, Southern Alkali Corp., Corpus Christi, Texas:

I believe Mr. Volkening is to be congratulated on the excellence of his paper which does much to explain similar observations which have been made during the past fifteen years on the use of steel piping in chlorinated seawater at our Corpus Christi, Texas plant.

We have noted a tendency for steel piping in contact with chlorinated seawater having chlorine residuals in the range 0.5-2.0 ppm to fail badly in instances where the velocity of the water was moderately high. Where only low or moderate velocities were encountered, the service life of the steel piping was fairly satisfactory. Unfortunately, we do not have any exact data on the service life of steel piping under these conditions, but observations have indicated that only a rather low water velocity could be tolerated.

Until the presentation of this paper, the short life of steel piping in this service under the higher velocity conditions had been attributed to the effect of seawater itself rather than to a combination of seawater and chlorine residual. However, it would appear now that it is the combined effect of the two

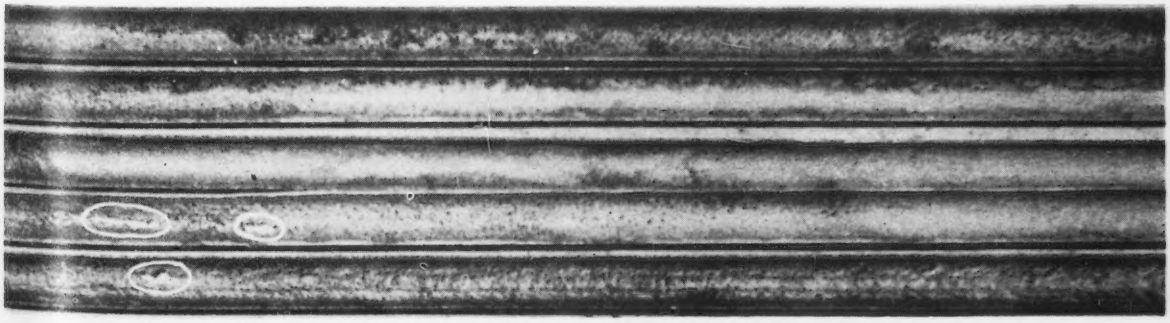


Figure 9—Pipe sections showing penetration by 2.0 and 4.0 ppm residual chlorine. Velocity 6.4 fps. Reading from top to bottom: 0.0, 0.5, 1.0, 2.0 4.0 ppm Cl_2.

conditions which is the predominant cause, rather than the effect of chlorine residual only, inasmuch as a similar effect is not observed in chlorinated fresh water.

It may be of interest to note that under conditions of velocity and residual which would result in a short life for steel in contact with chlorinated seawater, cast iron gives excellent service. For this reason, an evaluation of the effect of chlorinated seawater at varying velocities on cast iron would appear to be a logical outgrowth of the work with steel. Any information on the effect of chlorinated seawater on cast iron would be of material value in industries and other applications where such waters are being handled.

By F. L. LaQue, Corrosion Engineering Section, The International Nickel Co., Inc., New York, N. Y.:

At our Marine Test Station at Kure Beach, North Carolina, we have carried out investigations of the effects of chlorine additions on fouling and corrosion using a test set-up and general technique very similar to that described by Volkening.

Results of our studies over a six months test period tend generally to support Volkening's conclusions and may be summarized as follows:

1. The continuous addition of chlorine to give an available concentration of either 0.25 or 0.5 ppm as measured with ortho-tolidine was sufficient to prevent the growth of macro-organisms (fouling), but permitted the accumulation of a little loose slime.
2. The intermittent addition of chlorine to give a concentration of 1.5 ppm in a cycle of 2 hours on and 2 hours off had about the same effect on fouling and sliming as the continuous additions of the lower concentrations of chlorine.
3. The intermittent addition of chlorine to give a concentration of 1.5 ppm in a cycle of 2 hours on and six hours off, or 3 ppm either 2 hours on and 2 hours off or 2 hours on and 6 hours off prevented fouling, but permitted the accumulation of more slime than in the case of the other treatments described.
4. The following table shows effects of chlorination and velocity on corrosion of steel and 70:30 cupro nickel alloys in the form of pipe sections of different sizes and of test specimens immersed in weir boxes:

CORROSION OF STEEL

Vel. in Ft./Sec.	INDICATED CORROSION RATES IN INCHES, Per Year						
	No. Cl_2	0.25 ppm. Cl_2 Continuous	0.5 ppm. Cl_2 Continuous	1.5 ppm. Cl_2 2 Hrs. On 2 Hrs. Off	1.5 ppm. Cl_2 2 Hrs. On 6 Hrs. Off	3 ppm. Cl_2 2 Hrs. On 2 Hrs. Off	3 ppm. Cl_2 2 Hrs. On 6 Hrs. Off
0.5	0.012	0.008	0.008	0.007	0.009	0.007	0.009
2.1	0.015	0.017	0.012	0.012	0.014	0.013	0.016
3.7	0.021	0.018	0.019	0.015	0.018	0.016	0.019
6.0	0.016	0.019	0.028	0.020	0.024	0.015	0.022
CORROSION OF 70:30—Cupro-Nickel							
0.5	0.0005	0.0002	0.0001	0.0001	0.0005	0.0002	0.0007
1.6	0.001	0.0002	0.0005	0.0003	0.001	0.0004	0.0015
2.1	0.001	0.0002	0.0001	0.0002	0.0008	0.0003	0.0009
3.7	0.0006	0.0002	0.0005	0.0003	0.001	0.0003	0.002
6.0	0.0005	0.0000	<0.0001	0.0002	0.0003	0.0000	0.0015
10.5	0.0014	0.0004	0.0006	0.0005	0.0013	0.0005	0.004

It seems evident from these data that chlorine may be added to seawater in concentrations sufficient to be effective in controlling sliming and fouling without introducing a serious corrosion hazard. Actually, a little chlorine seems to be favorable to the cupro nickel alloy and at least tolerable with steel if velocities do not become too high as suggested by Volkening's data.

It should be noted though that in connection with the steel pipe specimens the calculated velocities shown in the table are purely nominal, since all of the steel pipes became more or less plugged with rust which made the actual velocity at the steel:water interface very low and probably the same in all sizes of pipe at the end of the test. The clear openings in the different sizes of steel pipes after the tests were as follows:

Nominal Size	Diameter of Clear Opening Not Plugged With Rust
1¼"	¾"
1"	½"
¾"	½"

From the standpoints of both prevention of corrosion and prevention of fouling and sliming, the continuous addition of chlorine to give a concentration of about 0.5 ppm as measured with ortho-tolidine appears to be more desirable than intermittent additions of higher concentrations. Where intermittent treatment is preferred for other reasons, the frequency of the cycle should be kept high and the concentration of chlorine no higher than will give the required control of the organisms with the cycle used.

The Corrosion Products on Zinc Anodes Used Underground*

By E. A. ANDERSON*

Abstract

The presence of sulfates, such as gypsum, in the soil around zinc anodes used in the cathodic protection of pipelines has been observed to largely prevent the loss of current flow normally found after a time in ordinary soils. The present examination of the corrosion products on two anodes used in gypsum-bearing soil gave an opportunity to determine the mechanism by which sulfates affect the film resistance. It was found that the product adjacent to the zinc was a porous, needle or plate-like mass of crystals of basic zinc sulfate while the outerlayers were a dense, white mixture of the basic sulfate and basic carbonate. The permeability of the basic zinc sulfate layer probably accounts for its superior electrical conductivity. An hypothesis for the mechanism by which the two layers are formed is suggested in the paper.

ABOUT THE AUTHOR—E. A. Anderson, presently chief of Metal Section, Research Division, Technical Department, The New Jersey Zinc Company (of Pa.), Palmerton, Pa. He is a graduate of Yale University, Ph.B., 1920; M.S., 1923. His principal fields of activity are physical metallurgy of zinc and zinc alloys, corrosion of zinc and plating with and on zinc. He is a member of NACE, AES, ASM and AIME.

WHEN THE use of zinc anodes as a source of current for the cathodic protection of buried pipe lines was first initiated a number of years ago, the general experience was that the anodes would initially furnish enough current for protection if the soil had sufficient conductivity. It was found later, however, that in most soils the current flow gradually diminished to a small portion of the initial output. This was accompanied and presumably caused by the formation on the anodes of heavy layers of dense white corrosion products which apparently offered a high resistance to the flow of current. It was noted still later that in a few soils the current flow remained high and further that these soils all contained natural sulfates, usually in the form of gypsum ($CaSO_4 \cdot 2H_2O$). Acting upon this observation, a technique was evolved in which the hole in which the anode is placed is backfilled with a mixture of gypsum and bentonite clay** instead of the natural soil. Anodes so installed consistently have delivered a high percentage of their initial current over periods of at least five years at electrochemical efficiencies in excess of 90%.

While it seemed probable that this improved performance resulted from some change in the corrosion products due to the change in backfill environment, no data were available. Recently, however, two anodes used in a soil containing natural gypsum crystals were submitted by Mr. O. C. Mudd of the Shell Pipe Line Corporation. The examination of these anodes constitutes the work carried out in the present investigation. The findings, as detailed below, permit the formulation of a reasonable hypothesis to explain the observations.

Anode Samples

The two anodes received from Mr. Mudd had been in service in the Houston, Texas area in a stratum of sub-bentonite clay, which contained an abundance of natural gypsum crystals. The natural soil had been used as a backfill. One hereafter identified as C3743 was in practically complete form while the other, C3744, was a fragment.

Anode C3743 had been one of a group of four installed October 27, 1942. The anode originally had weighed 54 pounds and had been in the form of a 7-inch O.D. tube, 36 inches long, with a 5/16-inch wall. The tube had been formed by curling rolled strip into the desired shape. The butt joint was

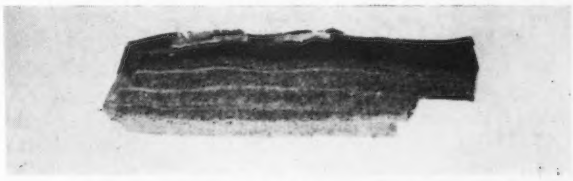


Figure 1—Cross-section of anode C3743 showing metal (black), gray corrosion products and white corrosion products. 3X.

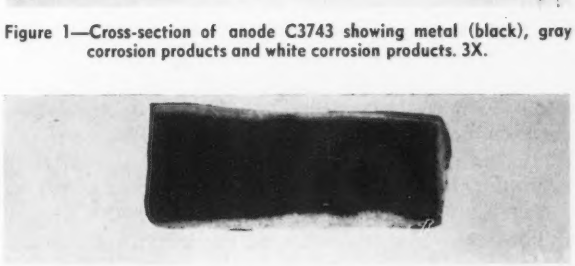


Figure 2—Cross-section of slightly attacked area of C3743 showing metal (black) and white corrosion products. 3X.

★A paper delivered at the Fifth Annual Conference, National Association of Corrosion Engineers, Cincinnati, Ohio, April 11-14, 1949.

*Technical Department, The New Jersey Zinc Company (of Pa.), Palmerton, Pa.

** Any possible patent situation in connection with this development should be investigated by those interested in the use of this procedure.

neither welded nor soldered. The soil resistivity in this area was 550 ohm-centimeter. The current output for the four anodes follows:

Date	Amperes
10/27/42	0.75 (Installed)
3/16/45	0.45
5/15/48	0.33 (Removed)

Anode C3744 was one of a group installed March 19, 1935. It was similar to anode C3743 except that the wall thickness was ¼-inch and the weight 43 pounds. The soil resistivity was 450 ohm-centimeters. The current output for the four anodes follows:

Date	Amperes
3/19/35	1.85
2/29/36	1.00
5/20/36	0.90
5/20/36	1.21*
9/ 9/38	0.78
3/ 6/39	0.51
3/20/48	0.10

* After tamping backfill around anodes.

The individual current readings for anode C3744 were measured twice during the run.

Date	Amperes
3/19/35	0.59
3/ 6/39	0.12*
3/ 6/39	0.65**

* Before removal and cleaning off of corrosion products.
** After replacing in original hole.
Note: The March 6, 1939, reading on the four anodes was taken before anode C3744 was removed and cleaned.

Tests Performed

Examination of anode C3743 revealed that the cross-section was substantially reduced in most areas, although in a few places little attack had occurred. A heavy white layer of corrosion products was present on the surface; beneath and adjacent to the metal was a gray layer. Typical cross-sections are seen in Figures 1 and 2.

A similar cross-section of anode C3744 revealed only a very thin film under the white layer. Outside of a structure photograph, no further work was done with this sample. Since the sample was in the form of a fragment, there is doubt as to whether it had been in the electrical circuit during the latter part of the test.

When examined at 100X, the gray layer on anode C3743 was seen to be composed of short needles overlapping in such a manner as to create considerable interpenetrating voids. These needles were nearly transparent and contained some metallic particles, presumably from the anode. These particles together with the probable presence of salts and metallic impurities from the zinc may account for gray color. The gray layer from C3744 was similar in nature, but the product was in the form of plates rather than needles.

The white layer was found to be a mixture of a skeleton structure similar to the gray film and a dense white material filling the interstices in the gray structure. This layer was obviously of limited porosity and probably was relatively impervious to water.

TABLE I—Chemical Analyses of Corrosion Products from Anode C3743

Analyzed for	PERCENT		PERCENT*	
	Gray	White	Gray	White
Zn	48.2	54.0	56.5	57.7
Zn as ZnO	60.0	67.2	70.5	71.6
CO_2	0.08	6.4	0.1	6.8
SO_3	14.0	8.4	16.5	9.0
H_2O†	11.1	11.7	13.0	12.5
H_2O‡	14.1	4.4	...	...

* Based on dry weight after heating at 110° C.
† Combined—above 110° C.
‡ Loss at 110° C.

The gray layer was identified as basic zinc sulfate by X-ray diffraction examination, and the presence of sulfate was confirmed by microchemical tests. The white layer seemed to be the basic zinc sulfate from the X-ray examination, but microchemical tests disclosed both carbonate and sulfate.

Chemical analyses were made on both layers with the results tabulated in Table I.

The data are in agreement in showing the gray layer to be essentially basic zinc sulfate and the white layer to consist of a mixture of basic zinc sulfate and basic zinc carbonate. The needle and plate forms of the basic zinc sulfate have both been observed in other work in this laboratory.

Discussion

The available data show that the double corrosion product film on the present samples is composed 1) of a dense outer white layer composed of a mixture of basic zinc sulfate ($3Zn(OH)_2 \cdot ZnSO_4 \cdot 4H_2O$) and basic zinc carbonate ($4ZnO \cdot CO_2 \cdot 4H_2O$) and 2) a porous inner mass of needle or plate structure composed mainly of basic zinc sulfate. It is concluded that the superior conductivity of the corrosion product layers produced in the presence of gypsum is due to the porosity of the basic zinc sulfate layer which permits ready permeation of conducting water.

The following tentative explanation is offered for the mechanism by which the two layers are produced: When the anode is placed in the soil, it comes into contact with water containing dissolved carbon dioxide and calcium sulfate. As current flows zinc ions enter into solution in the water and migrate a short distance from the anode surface. Hydroxyl, carbonate, sulfate and possibly other anions transported to the anode surface by the current endeavor to react with these zinc ions. While definite solubility data are not available, it seems probable that the basic carbonate of zinc is less soluble than the basic sulfate. Accordingly, the basic carbonate would be expected to form first, probably as a two-step operation involving the initial formation of zinc hydroxide and the later reaction of this salt with carbon dioxide.[1] Since the availability of carbon dioxide is limited by the semi-stagnant nature of the ground water, the point is reached where the reaction with sulfate takes precedence and the basic zinc sulfate starts to form.

The high mobility of the anions and the relatively low mobility of the zinc ion suggest that the former penetrate the film to form new film material adjacent

to the zinc surface. Thus, the outer white layers were formed first and the gray inner layers last.

It will be noted in Figure 1 that the corrosion product layer is laminated, six layers being detected. Since the anode had been in service for six years, an annual periodicity is indicated. This may well be connected with seasonal increases in ground water flow during periods of heavy rain. The white bands in the gray layer seem to be basic carbonate, presumably resulting from some such seasonal influx of fresh supplies of water containing carbon dioxide.

The continuous network of basic zinc sulfate in the white layer may have resulted from cracking during dry periods of previously formed basic zinc carbonate and the subsequent formation of the basic sulfate in the cracks.

The dense structure of the basic carbonate and the porous structure of the basic sulfate indicate the desirability 1) of having sulfates present in the environment and 2) of minimizing the access of carbon dioxide to the zinc surface.

References

See E. A. Anderson and M. L. Fuller, "Corrosion of Zinc," *Metals and Alloys*, September, 1939.

DISCUSSION

By Sidney E. Trouard, New Orleans Public Service, Inc., New Orleans, La.

The question was: Is it possible by means of forcing the zinc anode to collect current heavily (from a 6-volt battery) to rejuvenate an anode that has gone passive because of deposition of a zinc carbonate or zinc sulphate film? We have not gone into this to a great extent but have found through preliminary experiments that an anode can be rejuvenated for a short period by this process. No artificial backfill was involved.

Field and Laboratory Tests of Sodium Chromates and Alkalies For Controlling Corrosion in Gas-Condensate Wells*

By C. K. EILERTS, R. V. SMITH, F. G. ARCHER, L. M. BURMAN, FAYE GREENE and H. C. HAMONTRE*

Abstract

The results of investigations of the Bureau of Mines begun in 1944 have indicated that chromates are effective and economical inhibitors for controlling corrosion in gas-condensate wells. Rates of corrosion in the flowstring can be reduced to negligible values by maintaining low concentrations of the inhibitor in the water phase of the flowing fluid. The chromates are not equally serviceable in all wells and fields, and the principal problem of their use is one of preventing chemical reduction to insoluble hydrous chromic oxide which may be deposited on the walls of the tubing and obstruct flow. Maintaining a high pH in the flowstream by injecting alkalies with the chromates and avoiding high concentrations of the chromates in the flowstream are effective methods of minimizing the reduction of chromates by substances that occur in some reservoir fluids. Costs of chemical treatment in two gas-condensate fields indicated that corrosion protection by means of sodium chromates and alkalies adds less than $1.00 to the expense of producing a million cubic feet of gas.

THE BUREAU OF MINES began its investigation of the use of chromates for controlling corrosion in gas-condensate wells in 1944 and the results of field and laboratory tests obtained since then have indicated that these compounds are effective and economical inhibitors. Rates of corrosion in the flowstring of gas-condensate wells now can be reduced to negligible values by maintaining low concentrations of the inhibitor in the water phase of the flowing fluid. The chromates are not equally serviceable in all wells and fields, and the principal problem of their use is one of preventing chemical reduction to insoluble hydrous chromic oxide which may be deposited on the walls of the tubing and obstruct flow. Maintaining a high pH in the flowstream by injecting alkalies with the chromates and avoiding high concentrations of the chromates in the flowstream are effective methods of minimizing the reduction of chromates by substances that occur in some reservoir fluids. Costs of chemical treatment in two gas-condensate fields indicated that corrosion protection by means of sodium chromates and alkalies costs less than $1 per million cubic feet of gas produced.

Although sodium or potassium chromate as the principal or sole ingredient of some corrosion-inhibiting materials had been in extensive use in other industries for many years, little was known before 1944 concerning the effective use of these compounds for preventing corrosion in gas wells. The Cotton Valley, La., field, where most of the Bureau of Mines tests with sodium chromates were made, is one of the first gas-condensate fields in which the effects of corrosion on well equipment were observed. It was determined early in the tests in this field that the use of relatively inexpensive quantities of the chromates would reduce the rates of corrosion of well equipment to negligible values. Rates of corrosion of test coupons installed in the well head could be reduced from 0.045 ipy (inches penetration per year) to 0.002 ipy, and at the same

*Presented at the Gas Industry Symposium of the Conference of the National Association of Corrosion Engineers in Cincinnati, Ohio, April 11, 1949. The full text of this report, which included 18 tables and 20 figures was published in *World Oil*, Vol. 129, 142-50, 173-182, 156-164+, 174-180, 156-170, 160-168 (1949) July, Aug., Sept., Oct., Nov., Dec.

*All with Petroleum and Natural Gas Branch, United States Department of the Interior, Bureau of Mines, Bartlesville, Okla.

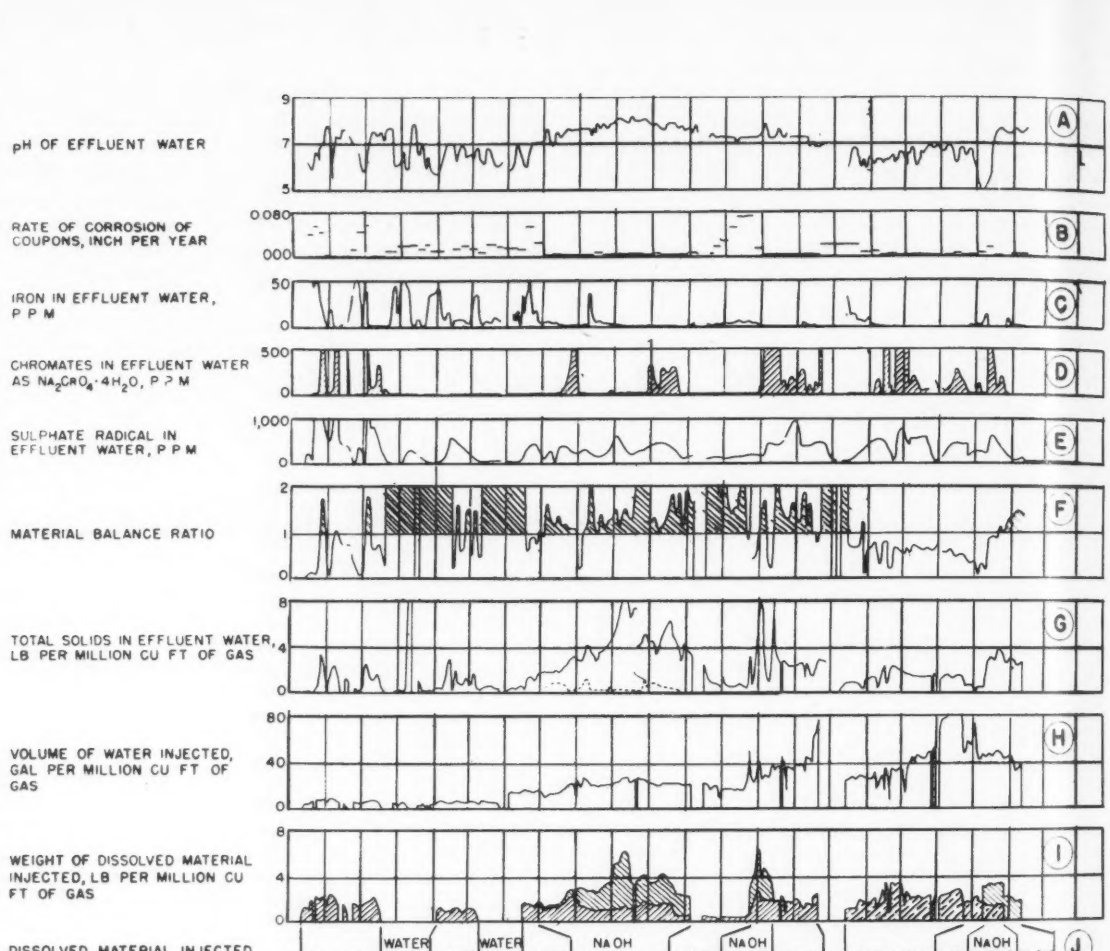


Figure 1—Summary of tests of sodium chromates and alkalies for controlling corrosion in a gas condensate well, Cotton alley Field, La.

ime the iron (Fe) contained in the effluent water ould be reduced from 100 ppm (parts per million) to ppm by injecting 1.23 lb. of sodium chromate and 95 lb. of sodium hydroxide into the well to flow with ach million cubic feet of gas produced. Such treatment of the well provided an excess of chromates in he effluent water, averaging 75 ppm, so that the ellow color of a water sample withdrawn at the well ead afforded ready indication that the treatment was roceeding effectively and satisfactorily. Moreover, he flow capacity of the tubing was not changed by uch treatment, and reaction products apparently were arried to the surface in the flow stream as rapidly s they were formed.

The greater part of the experimental effort in the ield was directed toward determining how much the reatments could be varied without loss of required enefits and what results would be obtained when alues of important control factors were varied over wide ranges. As the flowing fluid, the well, and the operating conditions were not representative of all gas-condensate wells requiring protecting against corrosion, controlling factors were varied to extremes, so that the information obtained would be applicable to as many wells and conditions of operation as possible.

It was found that excessive concentrations of chromates in the flow stream were conducive to reduction of the inhibitor to insoluble, non-protective compounds. On the basis of the results of 12 tests with mixtures of sodium chromate and sodium hydroxide, the quantity of inhibitor consumed during the flow of a million cubic feet of gas was 1.33 lb. when the effluent water averaged 373 ppm and 1.20 lb. when the concentration of surplus inhibitor in the produced water averaged only 75 ppm.

The treatments involving the lowest concentrations of sodium chromate in the flow stream maintained or increased the flow capacity of the tubing; excessive concentrations of the inhibitor, however, resulted in a lowering of its flow capacity. The best results were obtained when 1.2 lb. of sodium chromate, 1.9 lb. of sodium hydroxide, and 22 gal. of water were injected into the well to flow through the tubing with each million cu. ft. of gas produced. A concentration of 50 ppm of sodium chromate in the effluent water was enough for complete corrosion control throughout the entire length of the tubing and the christmas tree.

The results of these tests in which the rate of injecting inhibitor into the well was varied suggested that inhibitor concentrations in the flow stream could be further lowered and inhibitor conserved by diluting the flowing solvent phase with large volumes of injected water. Consequently, tests with both sodium chromate and sodium dichromate solutions were made in which 6 to 86 gal. of water were pumped into the annular space between the casing and tubing per million cubic feet of gas produced. Although this range of injection rates provided for increasing, by a factor of 6 or more, the volumetric rate of flow of water entering the tubing and, by a factor of 2, the volumetric rate of flow of water flowing through the christmas tree, results obtained did not show that advantage was gained by diluting the flow stream with water. It was estimated that in the absence of injected water a million cubic feet of gas entering the tubing was undersaturated to the extent of 5 gal. of water. For most of the field tests, a minimum of 20 gal. of water was injected into the well per million cubic feet of gas produced so that liquidwater would be available to carry the inhibitor through the bottom 400 or more feet of tubing.

Figure 1 was prepared to provide a graphical summary of part of the results obtained during the 20 months that tests were under way at a well in the Cotton Valley field. Sections H, I, and J show the nature and duration of the treatments with various sodium chromate and alkali solutions; sections A to G, inclusive, show significant changes in the properties of the effluent water and corresponding measures of the resultant corrosion control. Sections K, L, and M show the effect of the treatments on the flow capacity of the tubing.

The pH of the liquid water flowing through the tubing was found to be an important factor in controlling the conversion of soluble chromates to insoluble, reduced chromium compounds. Chromic acid injected into the flow stream caused the effluent water to have a pH of 5.1, and the equivalent of 2.66 lb. of sodium chromate per million cubic feet of flowing gas was reduced to the deposit-forming, hydrous chromic oxide. The flow capacity of the tubing was lowered by this treatment. Sodium dichromate, sodium chromate and sodium chromate plus sodium hydroxide each were injected in a series of tests to provide successively higher values of pH in the flow stream. The combination of sodium chromate and sodium hydroxide rendered the water in the flow stream the most alkaline; the pH of the effluent water averaged 7.7. In this alkaline treatment, only 1.20 lb. of sodium chromate per million cubic feet of gas were reduced to chromic oxide, and the flow capacity of the tubing was either maintained or increased as the deposits on the walls of the tubing resulting from former well treatments were removed by the flow stream.

The cost of using chromates for protecting wells against corrosion depends to a considerable extent on the cost of special equipment used in the treatments and on the extent of the precautions which are taken against such a hazard as the possible loss of control of wells through failure of high-pressure equipment. Experience of operators in the Erath field (Louisiana) with injecting sodium dichromate into wells indicates a total cost of $11.33 per day per well. Costs of similar operations in the Sheridan field (Texas) of injecting a commercial inhibitor into wells average $7.87 per day per well. Injection operations in the two fields are similar in many respects; and if the cost of the extra string of casing used in the wells in the Erath field is not considered, the average of injection costs for the two fields is $6.32 per day per well. Cost records in both fields are based on average production rates exceeding 6.3 million cubic feet of gas per day per well; and, on the basis of these records, corrosion protection by means of chromates adds less than $1 to the cost of producing a million cubic feet of gas.

DISCUSSION

Remarks by Edward C. Greco, United Gas Pipe Line Co., Shreveport, Louisiana:

This paper of Eilerts and co-workers is extremely interesting and represents a very excellent piece of practical research on inhibition of corrosion in gas condensate wells by means of chromates. There is no doubt that the data in this paper will be quite useful to the oil and gas industry.

Studies of this kind are necessary since all the available data on chromates heretofore has been pertinent to systems containing oxygen, where quite substantial residuals (250-500 ppm) of chromate are necessary for maintaining a continuous protective film. The systems we are dealing with—condensate wells—are anaerobic, and the available data published for aerobic systems cannot be extrapolated to treatment of these wells.

In the early days of inhibition of corrosion in condensate wells by means of chromates it was thought that large concentrations of chromates were necessary, and that returns of 200 to 300 ppm and even higher were desirable. I am glad to see that the researches carried out by Eilerts and co-workers have disproved this idea and established the fact that a concentration of 50 ppm of chromate in the effluent is adequate for maintaining a continuous protective film.

It should be emphasized here that an excess of an inhibitor in some systems is just as bad as not enough inhibitor, and in the case of chromates in condensate wells, an excess of inhibitor enhances the formation of deposits of reduced chromate.

In our work with dichromates we found that a residual of 50 to 60 ppm chromate in the effluent water was consistent with satisfactory corrosion inhibition and that the tendency for the formation of a plug of reduced chromium was negligible. The practice of "slugging" heavy concentrations of chromates (3 lb./mmcf) of produced gas increases the possibility of forming reduced chromates (Cr_2O_3) and subsequent plugging. I am certain that in most instances the injection of 2 to 3 lb. of chromate per mmcf of gas to establish initial returns of the inhibitor is a mistake, and a major source of trouble.

In one instance we found after stopping chromate injection for some twenty-six days that the effluent water still contained a residual of 44 ppm of dichromate. The iron content of the produced water was 23 ppm as compared to an original 183 ppm before the dichromate treatment was begun, indicating that the well tubing was protected throughout the 26 days without chromate injections. Our experience has been that chromates are effective inhibitors in condensate wells provided proper techniques and controls are employed.

Mr. Eilerts has referred in his paper to the possibility of reducing the effectiveness of carbon dioxide by some means other than complete neutralization of the carbonic acid in the water phase. I should like to go a step beyond this, if I may, and propose a hypothesis on the mechanism of corrosion evolved in condensate wells.

I am sure we are all familiar with the fact that carbon dioxide dissolves in water to give rise to carbonic acid, and by further ionization, hydrogen ions and bicarbonate ions rendering the solution acid according to the equations:

$$CO_2 + H_2O \rightleftharpoons H_2CO_3$$
$$H_2CO_3 \rightleftharpoons H^+ + HCO^-_3$$

In this state carbon dioxide reacts quite readily with metals and alkaline earths forming bicarbonates:

$$Fe + H_2CO_3 \rightarrow Fe(HCO_3)_2$$
$$CaCO_3 + H_2CO_3 \rightarrow Ca(HCO_3)_2$$

By their very nature these bicarbonates are protective as they are laid down on the metal surfaces. According to Evans,[1] water containing carbon dioxide under pressure dissolves iron, producing soluble ferrous bicarbonate, but the rate of attack falls off as the bicarbonate accumulates. Thus it is reasonable to assume that if carbon dioxide were present alone, a film of ferrous bicarbonate and carbonate would be plated on the metal parts, and a state of equilibrium would be reached. However, the presence of organic acids, acetic, propionic, etc., in concentrations of 80 to 100 ppm tends to shift the equilibrium and allows corrosion to proceed at some steady rate. The products of reaction of the lower-molecular-weight fatty acids and the metals are soluble in water and thus have no protective qualities.

Another factor which must be considered is the effect of the bicarbonate ion in solution on the pH of that solution. It is reasonable to assume that as the bicarbonate ion concentration increases in the solution, the pH to which that solution may be lowered by dissolved carbon dioxide is quite limited.

From an extensive survey made by Cummer, Russell, and Greco, of corrosion in one field, the data indicate a rather clearly defined relationship between organic acid content of the produced water and the rate of corrosion as indicated by well head coupons. The first order partial correlation coefficient was significant, indicating a definite tendency for high mills per year penetration to be associated with high organic acid content.

1. U. R. Evans, Metallic Corrosion Passivity and Protection, Longmans, Green and Co., London, 1946.

Discussion by Marc Darrin, Mutual Chemical Company of America, Baltimore, Maryland:

Controlling corrosion in deep gas-condensate wells is very important. It is also difficult, but the basic problem has been solved by a small group of men under the leadership of Kenneth Eilerts of the Bureau of Mines. We have heard their report and I am honored in being asked to discuss it.

As you know this work was started during 1944. From the first Eilerts visioned the use of chromate, and we exchanged thoughts, first by letter, later by meetings and field inspections. It may surprise you that I, a representative of a manufacturer of chromium chemicals, at first discouraged him. It was thought that organic compounds in the gas might reduce

chromate too quickly, and, since this chemical has many meritorious applications in the oil and gas industries, we were reluctant to suggest its use in gas wells. But this did not deter Eilerts, although he did decide to lower its chemical activity by raising the pH.

About this time an honored member of this society, Dr. F. N. Speller, reported that chromate injection into gasoline pipe lines was successfully inhibiting corrosion. Another group of investigators in the Permian Basin of West Texas, sponsored by the American Oil Well Drillers Association, found that chromate in drilling muds was helpful in controlling corrosion-fatigue of the drill string. By the fall of 1946 we were convinced that Eilerts was on the right tract, and early the following year we inspected several chromate-treated wells in Texas and Louisiana, and Eilerts reported progress at the Dallas meeting of the Corrosion Research Committee of the Natural Gas Association of America. I was present at this meeting. Some of the gas well operators were concerned over mechanical failures and servicing difficulties. Others seemed to be seeking a remedy such as a doctor would prescribe for a disease—a strong dosage of a chemical which would effect a cure. As we now know there is no "one-shot" remedy, instead an inhibitor must be injected continuously.

It is apparent from Eilerts' data that the iron content of the water which separates at the well-head is reduced from several hundred parts per million to less than 10 ppm, as long as a little hexavalent chromium is maintained in the effluent. This is after conditions have become stabilized, which is usually within a few weeks. Nevertheless several instances can be cited where chromate treatment did not prove satisfactory. Tubing deposits developed in some wells. In others operators were unable to obtain a return of chromate in the wellhead water. There were difficulties due to mechanical details of injection and servicing, or the manner of well-completion. Other difficulties related to pH, concentration and rate of injection. Some may have been due to prior experimental injection of other chemicals, or to unusual salts in the ground water. For instance, one tubing obstruction was found to contain a large amount of calcium phosphate, another strontium carbonate—but these are isolated instances.

Some difficulties were thought to be due to undersaturation of the gas with respect to water, thus depositing solid sodium chromate. The suggested remedy was to use the more soluble sodium bichromate and inject a greater volume of water. This is being done with outstanding results in a number of deep wells, but, as Eilerts points out, it may not provide 100⅔ protection. There is also a little higher consumption of inhibitor, but the protection is quite satisfactory, averaging better than 90%. Efficiency of protection is calculated as percentage reduction in iron content of the effluent.

Eilerts prefers, where conditions permit, to employ a dilute sodium chromate solution because of its somewhat greater protective value and lower chemical activity. To do this requires reliable and flexible injection equipment such as an electrically driven unit, as contrasted with gas-actuated injectors of the diaphragm-motor type or the common lubricator type of injector. In many instances the electrification of a gas field is comparatively simple.

Although a large number of helpful conclusions may be drawn from Eilerts' comprehensive work, I would like to emphasize two which are of major practical importance.

1) Best results require injection equipment with reliable and flexible motive power, capable of maintaining uninterrupted service at all times.
2) The major criterion of effectiveness of the treatment is the reduction of the iron content of the effluent. The only other control tests generally required are pH and hexavalent chromium.

Assuming that the correct injection equipment has been installed, the corrosion engineer should adjust the pH, concentration and the gallons injected per day, until optimum results are obtained for each well. With lapse of time, conditions change and it may be necessary to readjust concentrations and volumes, but this should be done on the basis of trends over a period of time as may be expressed by graphs, rather than based on analysis of individual samples. Ordinarily the iron and pH of the effluent remain substantially constant, and adjustments are made on the basis of hexavalent chromium. As mentioned, Eilerts suggests a low maintained concentration when using chromate, say 50 ppm, but when bichromate is used good results have been reported with higher concentrations, 200 to 500 ppm. Iron content should run well under 10 ppm Fe. The pH may vary depending on individual conditions, from the natural low pH produced by sodium bichromate, to above the natural high pH of sodium chromate.

The primary purpose of chemical injection is to prevent corrosion of the tubing and parts of the well-completion deep in the ground. Simultaneously this may protect the christmas tree fittings, and possibly the gas lines, but a measurement of the corrosiveness of the produced gas is not a criterion of corrosion taking place in the well. A corrosive gas may expend its corrosiveness in lower sections of the steel tubing and become comparatively non-corrosive when it reaches the surface. On the other hand, the corrosiveness of the gas may be inhibited so as not to attack the well tubing, but its inherent aggressiveness may return above the ground if the inhibitor is depleted. Thus it is that measurement of corrosiveness of a gas-stream is not a definite criterion of corrosion below the surface.

It is quite understandable that some field operators, charged with maintenance, are concerned chiefly with corrosion above the ground, but it is our responsibility to repeat and repeat that the cost of replacing surface equipment is of a lower order than that of the tubing and well-completion. As Eilerts' data show, the primary purpose is attained when the iron content of the effluent is reduced to a negligible figure. Of course, reduction of corrosiveness of gas leaving the well-head also is desirable and frequently realized.

In conclusion, may we again congratulate Kenneth Eilerts and his co-workers, and their sponsors, for the important contributions they have made in combatting corrosion in several severely corrosive gas fields, and

we sincerely hope that they will continue this work extending it to all gas fields. Thus far efforts have been directed chiefly toward wells with expected tubing life of less than three years, some less than one year. The life of these wells has been prolonged indefinitely. Obviously it would be desirable to extend the life of all gas wells. If this program is undertaken it is urged that not only the gas well operators collaborate with Eilerts, but also the manufacturers of injection equipment.

I shall be glad to join Eilerts in answering such questions as time permits, but first let me ask him a question: "How many corrosive gas wells do you estimate are in this country." It is realized that in replying it may be necessary to define what constitutes a corrosive well, say based on expected tubing life.

Reply by Kenneth Eilerts:

Mr. Waldrip in the audience has some unpublished data that are pertinent in answering Mr. Darrin's question; perhaps Mr. Waldrip will discuss the information he has concerning the number of gas-condensate wells known to be subject to corrosion.

Remarks by H. E. Waldrip, Gulf Refining Co., Houston, Texas:

In my paper given last year at St. Louis, I reported a total of 1,334 gas wells, of which 232, or 17.5%, are considered corrosive, and these were either being treated, or were marked for treatment. Mr. W. H. Stewart, chairman of the NGAA Research Project Committee recently circulated a questionnaire requesting this information and the number reported to him as being corrosive was approximately 565. This number is more than double that which was reported to me about one and one-half years earlier, and it seems that several producers now consider wells to be corrosive which they did not believe to be corrosive when I made my survey.

Reply by Kenenth Eilerts:

In reply to a part of Mr. Darrin's question I would like to add that when Mr. Frank S. West made a similar survey in 1946, he defined a well subject to corrosion as one for which the tubing string, tree fittings, or flow line was corroded at a rate such that it had to be replaced or repaired approximately once each year.

Question by Mr. R. MacFarland, Technical Director, Hills-McCanna Co., Chicago, Ill.:

Will the deposit of chromate and scaling of tubing be prevented by use of sequestering or chelating-type inhibitors, such as sodium metaphosphate, high molecular weight amines, and the new chelating material, ethylene diamine tetra acetic acid?

Reply by Kenneth Eilerts:

We have made some laboratory tests at room temperature with the sodium phosphate glass sold under the trade name, "Calgon," but did not obtain indications that this compound would be useful for preventing the formation of deposits of hydrous chromic oxide in the tubing of wells. Lumps of the deposit removed from a section of tubing were washed continually in a siphon cup with a 20-ppm solution of the phosphate for 250 days without apparent alteration of the structure and texture of the lumps. Gas-condensate reservoir temperatures usually are higher than 180° F and an hour, more or less, may be required for a treating solution to trickle downward through the annular space to the tubing entrance and then return to the surface with a flowing fluid. At such temperatures, a substantial percentage of the phosphates in the treating solution would revert to ortho phosphate and thus loose sequestering capacity before it entered the tubing.

We have not tested ethylene diamine tetra acetic acid but I understand that this compound is effective at relatively high temperatures.

Topic of the Month

Recent Developments in Glass-Lined Pipe

By S. C. ORR*

WITHIN THE past year several important new developments have occurred in the manufacture of glass lined pipe which are extending its field of application and contributing to its serviceability.

Heretofore, glass lined piping for highly corrosive service has been exclusively of the Van Stone flange design and of carbon steel throughout. While this is convenient in most chemical installations, certain services, particularly within the petroleum industry, require the use of couplings for pipe connections rather than large diameter flanges. A newly developed joint** (See Figure 1) permits the use of pipe couplings while preserving the inherent corrosion resistance of glass lined carbon steel flanged pipe.

In this design, two short rings, of highly resistant alloy, are welded to the ends of a length of low carbon steel tubing. The glass lining is applied through the length of the pipe by conventional means *but it terminates at either end on the alloy ring.* Following the glass lining operation, the pipe is threaded with standard dies and may be connected by alloy couplings. Alloys thus far available for the terminal rings are Hastelloy, Inconel, Type 347 stainless steel, and the extra low carbon grades of Types 304 and 316. Pipe couplings may be of these or other alloys which possess adequate resistance to corrosion by the product.

Because small areas of the alloy rings are exposed to the corrosive medium, this ring material must be selected for its resistance to chemical attack. The five alloys presently offered cover a wide band of service requirements.

Alloy requirements are cut to negligible amounts, conserving critical and costly materials, by using carbon steel instead of alloys for the major portions of the required material. Thus far the new construction is available in 2-inch, 2½-inch, and 3-inch pipe sizes in lengths up to 10 feet and 1½-inch in shorter lengths. As additional market applications develop and demand warrants capital investment in further manufacturing facilities, it is expected the piping will be offered in greater diameters and lengths.

In the manufacture of conventionally designed glass lined piping of the Van Stone type, flanges heretofore have been pressed from low carbon rimmed steel plate. While these flanges are glass-lined satisfactorily from a ceramic standpoint, they present certain mechanical difficulties. Flange radii are so large that relatively little flat remains for a gasket seat and the flanges possess an inherently low flexural strength.

A practical solution to these limitations is offered by improved forging steels and techniques. Accordingly, the entire line of pipe flanges for glass lining was redesigned to take advantage of these improvements. Forged flanges of low carbon fully killed steel currently are being employed. These have reduced flange radii and larger outside diameters which result in a significant increase in flat area. Fillet radii on the back of the flanges have been altered to provide increased metal thickness through the faces and necks, thus adding to their mechanical strength. (See Figure 2.)

Coincident with the revisions in pipe flange construction have been improvements in material and design of glass lined cast iron fittings. Flanges of the new cast iron fittings have been altered to correspond

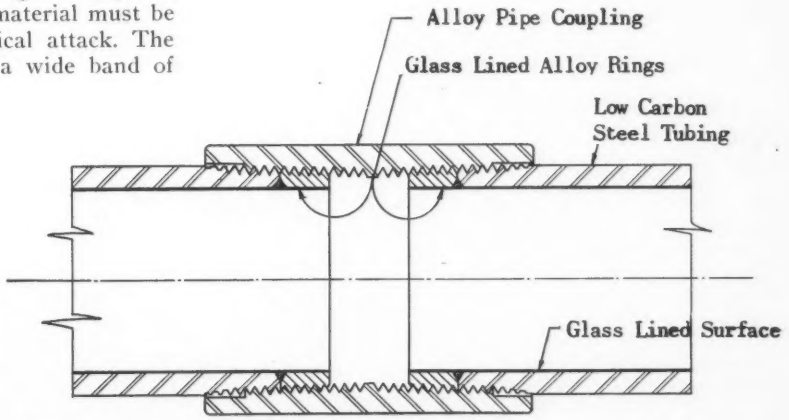


Figure 1—"Glassaloy" joint.

* Chief Ceramist, The Pfaudler Co., Elyria, Ohio, and Rochester, N. Y.
** "Glassaloy." Patented.

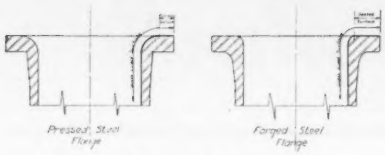


Figure 2—Comparison of pressed and forged steel flanges, glass lined.

with those of the new steel pipe flanges and foundries are now producing these castings in high strength irons.

Currently under investigation as a material for cast fittings are the even newer ductile or nodular cast irons. If this program is successful, objections to brittle materials in pipe lines will be resolved substantially.

One limitation to ease of installation of glass lined pipe has been the inability of users to produce makeup lengths in the field. This has demanded complete and precise engineering of piping layouts prior to order placement. Errors of closure or revisions during installation have resulted in delays while glass lined pipe sections of specified length were fabricated. A newly developed porcelain spacer, which can be field-cut to any prescribed length, answers this problem (See Figure 3).

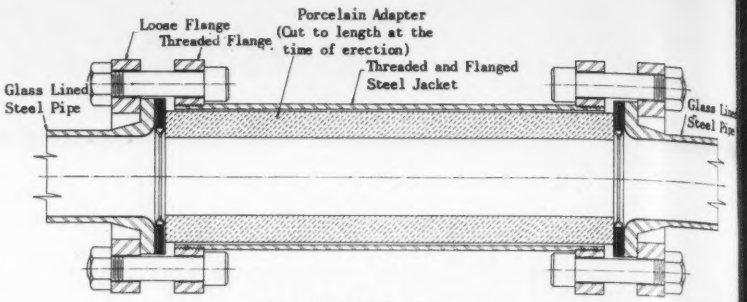


Figure 3—Field spacer connection.

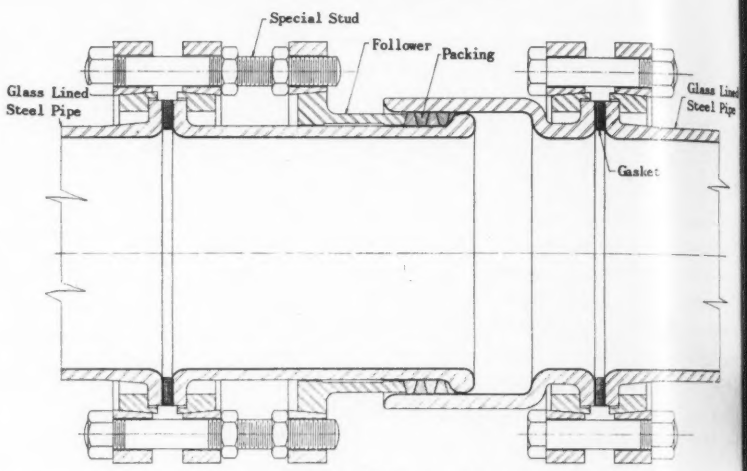


Figure 4—Expansion joint.

Essentially, the porcelain adapter consists of a stock length of porcelain pipe, a light wall steel jacket, and two threaded steel flanges. The porcelain spacer can be field-cut readily to the required makeup length. The steel jacket is cut and threaded on a standard pipe machine, the flanges are assembled, and the jacket is slipped over the porcelain spool piece. The assembly then can be installed between mating flanges of the glass lined pipe. The length of the steel jacket is not critical within broad limits because takeup is by means of connecting bolts. The steel jacket functions as an armor shield, minimizing the danger of damage to the porcelain spacer during installation or while in service. The porcelain spool piece is under compression, thus bolt loads sufficient to insure a tight seal are less likely to cause breakage which might result from misalignment or tensile stresses.

For glass lined pipe installations subjected to alternating thermal stresses, a glass lined expansion joint has been developed (See Figure 4). This permits linear motion of plus or minus ¾-inch. It consists of a flanged glass-lined male section of the appropriate pipe size, a flanged glass-lined female section whose internal diameter is belled out, suitable packing, packing gland and special studs. Principal use of this joint has been in vertical columns. However, with suitable hanger supports it is equally adaptable to horizontal lines.

NACE News

Recipients of 1950 NACE Awards

O. C. MUDD

Senior Corrosion Engineer, Shell Pipe Line Corp., Houston, Texas who is recipient of the 1950 Speller Award for achievement in the field of corrosion engineering.

ROBERT H. BROWN

Chief of the Chemical Metallurgy Division of Aluminum Research Laboratories, New Kensington, Pa., recipient of the 1950 Whitney Award for achievement in the field of corrosion science.

Dow Installation at Freeport, Texas Toured By 107 Houston Section Members March 14

Dow Chemical Company installations at Freeport, Texas were inspected during the afternoon of March 14 by 107 members and guests of Houston NACE Section. The gathering also was entertained at Lake Jackson Club nearby with a barbecue supper by Dow Chemical Company after which Gordon L. Doremus of Cathodic Protection Service, Houston, delivered a talk on "Cathodic Protection of Fourteen Offshore Platforms." Some of the visitors present for the program were from other sections including Corpus Christi and North Texas.

The tour at the Dow plant included inspections of the paint test racks, atmospheric corrosion test racks, sea water magnesium anode installations, radar hurricane locator and the plant for production of magnesium from sea water.

Mr. Doremus covered problems involved in these specialized magnesium anode installations from both electrical and mechanical standpoints. The talk was augmented by slides showing curves of experimental results and pictures of actual installations.

Following Mr. Doremus' talk, Perry Spafford, Stanolind Oil and Gas Company, Houston showed an interesting film prepared by his company on its offshore drilling operations.

Plans for attending the St. Louis Conference were discussed and it was believed a representative group of Houston Section members would be aboard the special train planned.

Tentative plans for the April meeting include a dinner at Elliott's April 11 followed by a talk on corrosion of oil well production equipment by Harry Waldrip, Gulf Oil Corporation.

Radio Program

A radio program over St. Louis' WEW station at 2:45 p.m. Sunday, April 2, during which George Purdy, a member of the 1950 Conference publicity committee will interview George McComb and William Deacon on corrosion and the National Association of Corrosion Engineers has been arranged, Otto H. Fenner, local arrangements chairman for the conference advises.

St. Louis newspapers also are expected to assign reporters to cover the meeting and interview "name" members, he said.

Corrosion Resistant Valves Is Topic at North Texas Session

Jack Harris, division salesmanager for L. P. Valves for Cameron Iron Works, Houston told members of North Texas Section NACE about the new valves for corrosion and high temperature service developed by his firm. Mr. Harris explained to the 36 members and guests at the February 27 dinner meeting at Fort Worth, the merits of the valve which was developed by Cameron after 10 years of expermentation.

The Cameron LP Valve is distinguished by a removable sleeve in which the plug seats. Positive seal is afforded by inset flexible washers when the valve is closed because line pressure pushes liquid between the sleeve and valve body, compressing the sleeve against the plug. Both plug and sleeve are removable readily, facilitating repair and making possible economical use of special corrosion-resistant metals for parts exposed to corrosive media without the necessity of fabricating the whole valve body from high priced alloys. Mr. Harris pointed out also that overall dimensions of his valves, which are all-forged, tend to be less than conventional valves because extra strength to resist line pressure stresses is not necessary in the Cameron valve because of the characteristics of the seal. The valve does not require lubrication and this eliminates another source of trouble, he added.

Robert H. Cole was named chairman of a committee to arrange programs for the remainder of the year.

Attending the meeting from Houston, in addition to Mr. Harris were Ames Bliss, sales engineer, Cameron Iron Works, V. G. Ibert, LP valves salesman, Cameron Iron Works and A. B. Campbell, executive secretary NACE, all of Houston.

Sabine-Neches Group Hears Furfural Talk

Thirty-six persons of whom 13 were guests from Cit-Con Oil Corp., Lake Charles, La., were present at the February 23 meeting of Sabine-Neches Section NACE at Sunset Grove Country Club, Orange, Texas. The guests' principal interest was the paper delivered by Frank R. Jelenik, of Neches-Butane Company titled "Furfural Corrosion in Extractive Distillation Equipment."

R. P. Clarke, program chairman, announced a panel discussion for the March 15 meeting. He asked for questions in advance so answers may be the considered opinion of the panel.

St. Louis Group Hears Mudd and McComb

O. C. Mudd, senior corrosion engineer for Shell Pipe Line Corp., Houston, Texas, addressed 40 members and 50 guests at the February 20 meeting of Greater St. Louis Section held at Garavelli's Restaurant. His topic was "Protective Coatings."

Revisions of the section by-laws have been accepted, it was announced.

This was the largest meeting to date of the section.

•

Pipe line coatings are in reality electrical as well as physical insulation, comparative statistics on the cost of cathodically protecting uncoated and coated lines indicates, George B. McComb, of Standard Pipeprotection, Inc., St. Louis, told the St. Louis Section's December 19 meeting. Mr. McComb illustrated this contention by an example in his experience in which a pipe line company found it would cost $6000 in equipment to provide the 90 amperes needed plus an annual maintenance outlay of $370 to cathodically protect 4 miles of a 10-year-old 26-inch inadequately coated pipe line, and that after reconditioning and coating the line 28 miles could be protected by only 25 amperes.

Mr. McComb said practice at his company included bringing the pipe to be coated to a temperature over the dew point, grit blasting to bright metal, then the application of a primer dried by high velocity air over 75 degrees F., immediately followed by coating and wrapping to engineers' specifications.

Metallizing, Parkerizing Discussions Featured at Western Region Meeting

Two papers, "Metallizing for Corrosion Prevention," and "Use of Parkerizing in Corrosion Prevention," by Manley H. Clark of Clark Metallizing, Inc., and Sam Headlee of Parker Rust Proofing Co. respectively were presented at the February 15 meeting of Western Region in Roger Young Auditorium, Los Angeles. Present for the meeting were 48 members and 28 guests.

Long discussions following the papers were indicative of the wide interest in the two topics.

Chairman of the nominating committee of the newly-formed Los Angeles Section advised his committee recommended that regional officers continue to serve as sectional officers during the formation of the section until replaced by officers elected at the first regular meeting after adoption of by-laws. Nominations for officers were closed and it was announced a mail ballot will be sent section members. Next meeting is scheduled April 26.

MEMBERSHIP CARDS AVAILABLE

Association members in good standing will be issued on request a membership card in the National Association of Corrosion Engineers. Address requests to A. B. Campbell, Executive Secretary, 919 Milam Building, Houston 2, Texas.

NACE CALENDAR

NORTH EAST REGION — May 10, New York City.

GREATER ST. LOUIS SECTION— April 20, speaker Dr. N. E. Berry, Servel, Inc., Evansville, Ind. Tentative title "Corrosion Engineering." Joint meeting — AIChE, Engineers' Club and NACE.

HOUSTON SECTION — April 11 — Gas Condensate Well Corrosion Summary, H. E. Waldrip.

SOUTH EAST REGION — April 14, Atlanta, Ga. R. B. Mears, Carnegie-Illinois Steel Co., "Localized Corrosion."

LOS ANGELES SECTION—April 26.

TP-1A—PACIFIC COAST — Meeting scheduled monthly.

BOOK REVIEWS

ASTM STANDARDS ON INDUSTRIAL WATER. American Society for Testing Materials, 1916 Race St., Philadelphia 3, Pa. 142 pages, 6 x 9, paper bound. $1.75.

A monograph prepared by ASTM Committee D-19 on Industrial Water. It contains sections on sampling methods, analytical methods, corrosivity tests, methods of reporting and general testing methods. Appendices are: List of ASTM Symposiums and Technical Papers on Industrial Water, Regulations Governing ASTM Committee D-19 on Industrial Water.

The corrosion section's contents are "Corrosivity Test of Industrial Water (USBM Embrittlement Detector Method) and "Corrosivity Test of Industrial Water (NDHA Method).

Also available in reprint form is "Round Table Discussion on the Need for Standards for the Examination of Water-Borne Industrial Wastes," which covers Analysis of Water-Borne Industrial Wastes, Gaging and Sampling Water-Borne Industrial Wastes, and a joint discussion on these topics.

•

Notices of future meetings of NACE subdivisions are carried monthly under the heading "NACE Calendar" in each issue of CORROSION magazine. Notices for this column should be sent to Central Office.

Corrosion News Deadline: 10th of Month PRECEDING Date of Issue

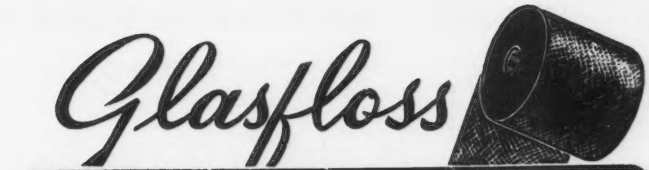
If you want Cathodic PROTECTION
not just Cathodic Protection Equipment
call ELECTRO RUST-PROOFING

No two corrosion problems are exactly alike — that's one reason stereotyped solutions won't work. Cathodic protection, properly engineered and applied, is economical, effective and practical. E.R.P. offers preliminary engineering, design, equipment and installation services for an individual solution to each particular problem. For data on cathodic *protection* of structures from pipe lines to elevated tanks, call on E.R.P. without obligation.

E-10

ELECTRO RUST-PROOFING CORP., (N.J.)
BELLEVILLE 9, NEW JERSEY
REPRESENTED IN PRINCIPAL CITIES

Glasfloss PIPE WRAP



The Underground Pipe Wrap That Is TOPS In These Most Important Features:

TENSILE STRENGTH . . .
Continuous glass fibers running full width of mat.

POROSITY . . .
Long glass fibers arranged in a pattern that gives maximum porosity.

BINDER . . .
Coal tar derivative.

Actual enlarged photograph of Perrault Glass Pipe Wrap, showing uniformity and continuity of glass fibers.

Available for immediate shipment...

from our Tulsa warehouse, or from factory at Hicksville, N. Y., in 400 foot rolls in widths 3", 4", 6", 9", 12", 18" and in 800 foot rolls in widths 9", 12", and 18".

DISTRIBUTED EXCLUSIVELY BY

PERRAULT *Brothers*

TELEPHONE 5-1103 • 1130 NORTH BOSTON • TULSA 6, OKLA.
EXPORT OFFICE, 30 ROCKEFELLER PLAZA, NEW YORK 20, N. Y. PHONE CIRCLE 6-6260

Pipeliners Who Attended Discussion Session in Crystal Ball Room Of Mo

Emphasis Placed on Practical Subjects at Tulsa Course

Practical aspects of cathodic protection and pipe line coating for superintendents, foremen, engineers and inspectors engaged in pipe line operations were stressed at the Short Course for Pipe Liners held at Tulsa, Oklahoma February 20-23. The event was sponsored by Tulsa NACE Section. Registration was 178. Registrants were from places as distant as New York, Montana and Utah, with Oklahoma, Kansas and Texas leading in representation.

Two field trips were made under direction of F. E. Pyeatt, Jr., Mid-Continent Pipe Line Co., James R. Cowles, Oklahoma Natural Gas Co. and J. N. Hunter, Jr., Stanolind Pipe Line Co. The trips enabled visitors to become familiar with techniques described.

Corrosion Surveys Explained

Monday's tour included demonstrations by E. P. Doremus, Cathodic Protection Service, Houston, on typical corrosion survey methods and design of galvanic anode installations. Current required to protect a poorly coated line was determined by employing a temporary ground bed and a DC generator especially designed for testing purposes.

Various methods of measuring soil resistance, pipe-to-soil potentials and locating "hot spots" on a pipe line were demonstrated. A "hot spot" was located by corrosion survey methods and protection was provided to the pipe at this point by magnesium anodes. Details of attaching leads, installing packaged as well as prepared backfill type anodes were demonstrated.

Annual Course Possible Section Officer Believes

Rectifier Demonstration

William E. Huddleston, Huddleston Engineering Co., Bartlesville, Okla., demonstrated a typical rectifier installation during the Tuesday tour. A practical method of determining the efficiency of a rectifier as well as methods of shooting trouble on a rectifier also were demonstrated. A typical bonding problem between a system under cathodic protection by a rectifier and a foreign pipe line with no cathodic protection was investigated and solved.

Wednesday and Thursday discussion sessions were under direction of R. L. Bullock, Interstate Oil Pipe Line Co., with Scott P. Ewing, Carter Oil Co.; J. C. Stirling, Stanolind Pipe Line Co.; E. W. Unruh, Sinclair Refining Co. and other members of the Tulsa Section participating.

Pipe Wrapping Discussed

The coating school, under leadership of Frank E. McNulty, Pittsburgh Coke & Chemical Co., gave attention to preparation of pipe surfaces preliminary to applying primers, the application of primers, enamel and reinforcing wrappers. Mr. McNulty emphasized the importance of clean surfaces and application of a thick coat of primer. Attention was called to wastage of coating materials to which pipe line management objected.

The group toured plants of Crutcher-Rolfs-Cummings, Perrault Bros. and M. J. Crose Manufacturing Co. Thursday afternoon. These manufacturers are actively engaged in research to develop new and better methods of serving the pipe lines.

Chairman R. L. Bullock said "Present indications are that the school on practical pipe line corrosion mitigation will be an annual affair under auspices of the Tulsa Section."

•

Oliver Osborn with Dow Chemical Company reviewed his paper "Combating Corrosion in a Chemical Plant with Magnesium Anodes," at the February 22 meeting of Corpus Christi Section, at the Princess Louise Hotel, Corpus Christi, Texas.

the Silent Watchman

DIXIE TANK *and* BRIDGE CO.

3523 Lamar Ave.—P. O. Box 14, MEMPHIS 1, TENNESSEE

Complete Service for Elevated Water Tanks—

NATION WIDE SERVICE—

32 Years Experience

KEEP THE SAFETY FACTOR IN YOUR TANK THE DIXIE WAY

By welding seams, pits and rivets which gives a riveted tank 15% more Safety Factor than it had when built. No rivets removed, water supply maintained while work is in progress.

On completely re-conditioned jobs, the painting is guaranteed for five years, repairs guaranteed for ten years, provided the tank is painted every five years. Yearly inspection, making all adjustments, if any, without additional cost.

Write Us for Free Copy of Publication

SOUND PRINCIPLES OF WATER TANK MAINTENANCE and TANK TALK

by W. A. Riley

DIXIE'S NATION WIDE SERVICE SATISFIES

Copyright 1949

THE LARGEST ORGANIZATION OF ITS KIND GIVING SAFE MAINTENANCE AT LOW COST

...ll Room Of Mayo Hotel, Tulsa During Section Short Course February 20-23, 1950

E. P. Doremus of Cathodic Protection Service, Houston, demonstrating technique of determining soil resistivity measurements by the four-pin method to pipe liners attending the Tulsa Short Course.

W. E. Huddleston of Huddleston Engineering Co., Bartlesville, Okla., describing procedure followed in installation of rectifier unit for cathodic protection system.

South Central Region To Meet on October 9-10

The 1950 annual meeting of South Central Region NACE will be held at Houston, Texas October 9 and 10, 1950 in the Rice Hotel. Lewis F. Scherer of the Texas Pipe Line Co., Houston, Texas has been named general chairman. Program chairman has not been named.

Welcoming address will be by R. B. McLaughlin, president of the Texas Pipe Line Company, Houston, Texas.

Tentative plans call for presentation of six technical papers with emphasis on practical subjects and discussions. Also contemplated is a tour of a pipe coating plant in this area. A panel discussion similar to that held at the 1949 meeting in Dallas also is planned.

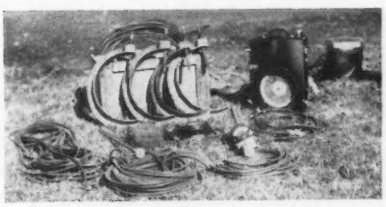
TP-3 Interim Report Available This Month

Copies of the first interim report of TP-3 on Anodes for Impressed Currents, giving details of the first year of tests on ground anode installations will be available at St. Louis. The 60-page report is the first issued by this group which has a four-year testing program under way.

Details of distribution have not been determined.

Nearly 500 standard samples of chemicals, metals, ores and ceramics are prepared, certified and distributed by the National Bureau of Standards.

A list of addresses of new members and changes of addresses of old members is a monthly feature of CORROSION magazine.



Something "Eating" You—underground?

This free bulletin describes the easiest, surest method of finding out if, where, and how badly electrolytic corrosion is attacking underground pipes and metallic structures.

Bristol Electrolysis Recorders give continuous, permanent records of electrical values involved in electrolysis surveys in a convenient form for study . . . so that you can locate dangerous conditions *before failure occurs.*

Especially constructed for portable use. Weatherproof case. Standard for as much as 40 years with leading utilities and electrolysis engineers. Send coupon.

BRISTOL
INSTRUMENTS

THE BRISTOL COMPANY
136 Bristol Road, Waterbury 20, Conn.
Please send bulletin on Bristol Electrolysis Recorder.

NAME_____
COMPANY_____
ADDRESS_____
CITY_____ STATE_____

TP-1A Pacific Coast Objectives Outlined

Objectives of TP-1A Pacific Coast—Corrosion of Oil and Gas Well Equipment were outlined as follows February 15 at an organization meeting of the committee:

1. Form a clearinghouse for discussing mutual corrosion problems.

2. Stimulate interest in NACE activities within oil circles and increase membership of the committee.

3. Serve as a clearinghouse in passing on to Pacific Coast oil industry information compiled by the national TP-1 committee, and forwarding to the parent committee information accumulated by the Pacific Coast group.

E. O. Kartinen, Signal Oil & Gas Company, was elected chairman and D. M. McCloud, California Research Corp., Los Angeles Basin, vice-chairman.

During the afternoon session the group discussed merits and faults of approximately 12 propietary corrosion mitigating "gadgets." No definite conclusions were reached.

Monthly meetings will be held, the next scheduled March 15 at 10:00 a.m. Standard Oil Building, 605 W. Olympic, Conference Room 29, Los Angeles, Cal.

Procedure on Distribution Of TP Reports is Given

A digest of each major report by NACE Technical Practices Committee subdivisions will be sent to all corporate members of the association with the suggestion that a complete copy of the report will be sent gratis if requested, Dr. Mars G. Fontana advised members of the committee in a letter dated February 15.

Other items covered by Dr. Fontana included: A second cycle of articles by chairmen of subdivisions of the committee for publication in CORROSION'S "Technical Committee Activities" page will be initiated. Each article will be followed by a list of the membership of each committee.

Chairmen of committee involved should prepare a condensation or summary to be published in CORROSION of reports too long for publication in the magazine, but which are to be published separately.

Paralled technical committees in various geographical locations should be set up as sub-committees of TP committees concerned, if necessary.

Worthy projects for which funds are not available should be written up for presentation to NACE as a proposal for sponsorship.

A. V. Smith Resigns

The resignation of A. V. Smith, Consulting Engineer, Bala-Cynwyd, Pa., as chairman of TP-4 Committee has been accepted by Dr. Mars G. Fontana, chairman of the NACE Technical Practices Committee.

His successor has not been named.

Over many years of service

HAERING ORGANIC GLUCOSATES*

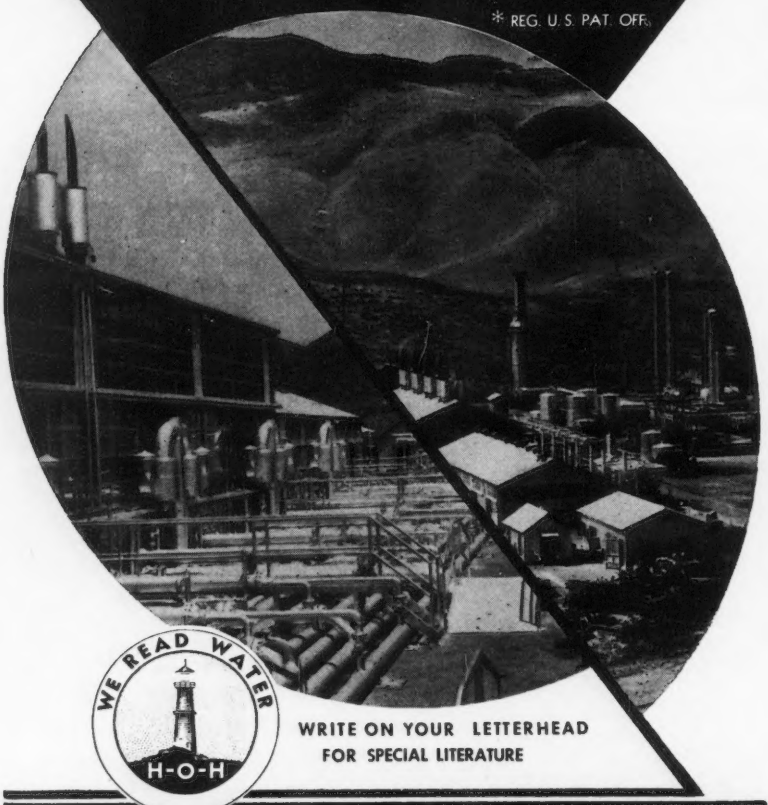
have an unexcelled record of performance in controlling

SCALE, CORROSION AND ALGAE

in the

PETROLEUM INDUSTRY

* REG. U. S. PAT. OFF.



WE READ WATER H-O-H

WRITE ON YOUR LETTERHEAD FOR SPECIAL LITERATURE

D. W. HAERING & CO., Inc.

Established 1931

General Offices P. O. Box 6037 San Antonio, Texas

Chicago Office, 205 West Wacker Drive

LAPEL PINS

CORROSION CONTROL

Approximately 7/16 inches high, gold, inlaid with bright red enamel background to "NACE" and deep blue enamel background to words "CORROSION CONTROL." Ruby center.

•

For Association Members Only

$7

Address Orders to

A. B. Campbell, Executive Secretary

NATIONAL ASSOCIATION OF CORROSION ENGINEERS

919 Milam Bldg., Houston 2, Texas

SOMASTIC★

..."ONLY 20 years old, but what a record!"

20 YEARS is a long time on the job, preventing corrosion damage to underground pipe. SOMASTIC Pipe Coating has furnished complete protection at severely corrosive locations since its first year—1930.

In fact, our knowledge of its useful life is limited only by the total time it has been in existence.

SOMASTIC IS The Best PIPE COATING

2 ECONOMICAL METHODS OF APPLICATION:

... by Central Plant

... by portable Railhead Plant

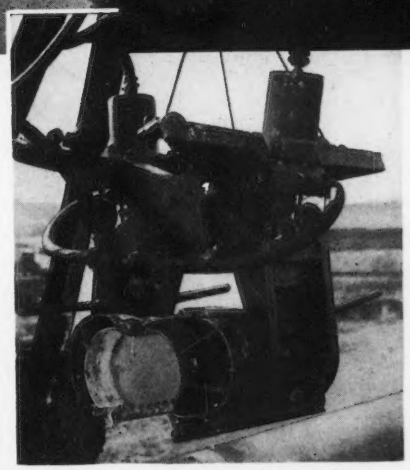
SOMASTIC PIPE COATING

*Reg. U. S. Patent Office

The sure protection of impervious asphalt-mastic—won't distort under soil stresses; resists shock; prevents electrolysis. Ductile; inert; firmly bonded to pipe.

RAILHEAD PLANT. Choice between railhead and central plant depends on the economics of a specific job.

HYDRAULIC FORM. Field joints make SOMASTIC protection continuous along the entire coated line.



Inquiries invited

H. C. PRICE CO.
SOMASTIC DIVISION
BARTLESVILLE, OKLAHOMA
In the 37 States East of the Rocky Mountains

BECHTEL CORPORATION
SAN FRANCISCO and
WILMINGTON, CALIFORNIA
In the 11 Western States and in Foreign Countries

St. Louis Conference Committee Meetings

Following is the schedule of committee meetings which will appear in the official 1950 NACE Conference program:

(Hotel bulletin boards should be consulted for confirmation of time and place of meetings.)

Sunday, April 2

10:00 A.M.—Board of Directors, R. B. Mears presiding.

Monday, April 3

8:30 A.M.—Combined meeting of Conference Committees, J. Pat Casey, Jr., General Chairman
Exhibits Committee, O. E. Murrey, Chairman
Local Arrangements Committee, O. H. Fenner, Chairman
Technical Program Committee, A. Wachter, Chairman

10:00 A.M.—Policy and Planning Committee, E. P. Noppel, Chairman
Publication Committee, Ivy M. Parker, Chairman
TP-1 Corrosion of Oil and Gas Well Equipment, Ted S. Zajac, Chairman
TP-2 Galvanic Anodes for Cathodic Protection, Walter P. Noser, Chairman.
TP-6 Protective Coatings, Kenneth Tator, Chairman
TP-7 Materials for use at High Temperatures, M. A. Scheil, Chairman
TP-8 Corrosion by Waters, V. V. Kendall, Chairman
TP-9 Corrosion Inhibitors, A. Wachter, Chairman
TP-13 Annual Losses Due to Corrosion, K. G. Compton, Chairman

2:00 P.M.—Abstract Committee, Margueritte Beddington, Chairman
Advertising Committee, R. H. Coe, Chairman
Membership Committee, H. H. Anderson, Chairman
TP-3 Anodes for Impressed Currents, D. H. Bond, Chairman
TP-4 Minimum Current Requirements for Cathodic Protection, A. V. Smith, Chairman
TP-10 Corrosion Fatigue, V. V. Kendall, Chairman
TP-11 Identification of Corrosion Products, C. M. Schwartz, Chairman
TP-12 Effect of Electrical Grounding on Corrosion, H. L. Hamilton, Chairman
TP-14 Instruments for Corrosion Measurements, R. F. Hadley, Chairman

4:00 P.M. Editorial Review Committee, F. N. Alquist, Chairman

Tuesday, April 4

9:00 A.M.—Correlating Committee on Cathodic rotection, H. H. Anderson, Chairman

10:00 A.M. — Regional Management Committee, L. A. Baldwin, Chairman
TP-15 Corrosion Control in the Transportation Industry, M. A. Williamson, Chairman

2:00 P.M.—Awards Committee, F. J. McElhatton, Chairman

Wednesday, April 5

4:30 P.M. — Officers and Symposi Chairman, A. Wachter, Chairman of Technical Program Committee
Technical Practices Committee M. G. Fontana, Chairman

Thursday, April 6

12:00 A.M. NACE Inter Society Corrosion Committee, H. H. Uhlig Chairman

4:30 P.M.—TP-5 Corrosion Problems in Processing and Handling Chemicals, M. G. Fontana Chairman

5:00 P.M.—Corrosion Correspondent Ivy M. Parker, Chairman

Friday, April 7

10:00 A.M.—Exhibitors, O. E. Murrey Chairman of Exhibits Committee

2:00 P.M.—Board of Directors, Van N. Jenkins presiding.

Paint Test Inspection

Arrangements were announced March 2 by Kenneth Tator, chairman of TP-6 Protective Coatings Committee for an inspection of paint performance on certain locks and dams in the St. Louis District U. S. Engineers' Office on Monday, April 3. Persons interested in seeing the tests are invited to contact Mr. Tator.

•

Changes in officers, or changes in addresses of officers should be brought to the attention of Central Office by secretaries of NACE regions and sections. Changes will be made as soon as possible in the monthly list "Directory of Regional and Sectional Officers."

Vitron*
GLASS FIBER
UNDERGROUND PIPE WRAP

SOLD ALL OVER THE WORLD BY

M. J. CROSE
MANUFACTURING CO., INC.
2715 Dawson Road, Tulsa, Okla.
Houston — New York — San Francisco

PERMANENT PIPE LINE PROTECTION!

- Reinforces the pipe coating.
  Retards cold flow in coatings.
  Increases impact strength of most pipe coatings.
- Will not absorb moisture — Glass Fiber is non-hygroscopic.
- Inert to soil chemicals.
- Hy-tensile and tear strength of mat results in simple uniform application.
- Excellent saturation characteristics with all types of pipe coatings.

WRITE FOR BULLETIN NO. V-69

*"VITRON is the registered trade mark of Glass Fibers, Inc., Waterville, Ohio."

Ladies' Entertainment Features Are Listed

Scheduled activities for ladies present during the 1950 St. Louis Conference were given as follows:

Tuesday, April 4—8:30 a.m., registration, mezzanine, Hotel Jefferson; 2:30 p.m., two-hour informal tea, Room 1, Jefferson Hotel; 6:00 p.m., Fellowship Hour, Gold Room, Hotel Jefferson.

Wednesday, April 5 — 12:00 noon, luncheon and afternoon of cards at Petit Pigalle. Busses leave hotel at noon.

Thursday, April 6—7:00 p.m., annual NACE banquet, Gold Room.

Friday, April 7—No planned entertainment.

Last-Minute Changes Are Made in Program

Last-minute changes in the 1950 St. Louis Conference and exhibit program and arrangements included:

Addition of the following technical paper to the program: "Control of Corrosion by Salt Used for De-Icing Highways," by John A. Temmerman, City Chemist, Rochester, N. Y. and Aaron Sterlin, National Aluminate Corp., Chicago, Ill.

Exhibition space assignments were changed as follows: Booth 20—Magnaflux Corp., Chicago; Booth 21—Protective Coatings Corp., Desplaines, Ill. Both booths were originally assigned to Magnaflux Corp

Posters Prepared

Posters advertising the 1950 St. Louis Conference have been prepared by W. F. Gross, chairman of the publicity committee from designs prepared by his wife. The 150 posters will be distributed to industries in the St. Louis area for posting in appropriate places.

Gulf Coast Engineers In AIChE Session

Several engineers from the Gulf Coast area participated in the "Protective Coatings in the Chemical Plant" session on the night of February 27 during the regional meeting of the American Institute of Chemical Engineers in Houston, Texas.

W. P. Schambra, Dow Chemical Co., Freeport, acted as moderator for the group of about 70 chemical engineers. Slides illustrating the Dow paint test program at Freeport were shown and discussed by V. B. Volkening of Dow.

The discussion included consideration of surface cleaning, surface preparation treatments, primers, finish coatings and specialized coatings. Miscellaneous problems discussed included high temperature coatings, such as silicones and the effect of cathodic protection on coatings. Some attention was given to the use of cement pigmented and mastic coatings for specialized chemical plant protection.

Texas A. & M. Corrosion Courses Content Given

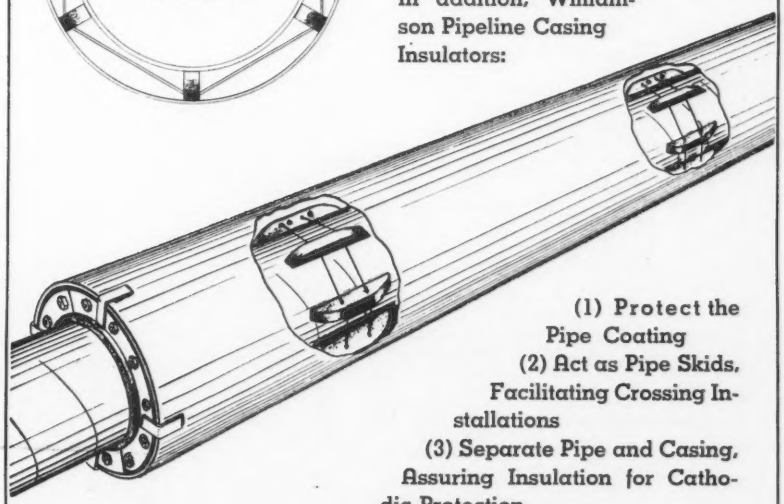
Recently introduced courses on graduate and senior levels at Texas A. & M. may offer a better understanding of corrosion and its prevention to chemical or chemical engineering graduates of the school, a recent release of information from Dr. Fred W. Jensen, head of the department of chemistry indicates.

A "Surface Coatings" course, introduced at the suggestion of the National Paint, Varnish and Lacquer Association is designated Chemistry 455. It carries a credit of 4. Topics listed in the syllabus include Drying oils, natural resins, synthetic resins, varnish cooking, hydrocarbon solvents, solvents for nitrocellulose lacquers, pigments, nitrocellulose, silicones, plasticizers, wetting agents, driers, fungicides, types of paints, enamels, lacquers, examination of raw material, evaluation of surface coatings and color.

Another course, "The Metallic Elements," listed as Chemistry 630 includes the following topics: Basicity, oxides, hydroxides of Periodic Groups I and II; valance forms, oxidation states and the electrochemical series; corrosion of metals, control factors; alloys and intermetallic compounds, systematic study of compounds of metals, complex ion formation, chemical reaction and energetics.

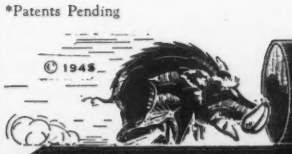
WILLIAMSON "CONCENTRIC SUPPORT" PIPE LINE CASING INSULATOR*

This improved Williamson Pipeline Casing Insulator approximately centers the line pipe in the casing. This removes support of pipe from "WmSEAL" Casing Bushings, and facilitates their installation. In addition, Williamson Pipeline Casing Insulators:



(1) Protect the Pipe Coating
(2) Act as Pipe Skids, Facilitating Crossing Installations
(3) Separate Pipe and Casing, Assuring Insulation for Cathodic Protection.

*Patents Pending



THE PIG WITH THE POKE CLEANS PIPE LINES

T. D. Williamson, Inc.
TULSA 9, OKLAHOMA

M. I. T. Announces Two Instrumental Analysis July Training Courses

Massachusetts Institute of Technology, Cambridge, Mass., will endeavor to provide means for practicing chemists in industry to gain familiarity with rapid and extensive changes in the application of instrumental methods in applied analytical chemistry at two one-week specialized training courses in instrumental analysis. They will be held July 10-14 and 17 and 21 as part of the 1950 summer session. Application forms may be obtained from Prof. Walter H. Gale, director of the summer session, Room 3-107, Massachusetts Institute of Technology, Cambridge 39, Mass. Dr. David N. Hume and Dr. Lockhart B. Rogers, both assistant professors of chemistry at MIT, will conduct the two courses. Facilities of the university's instrumental analysis laboratory will be used.

The first week's program will be devoted to electrical methods of instrumental analysis and will emphasize potentiometry, conductimetry, amperometric titrations and applications of self-balancing recording potentiometers.

Optical methods, including spectrophotometry, colorimetry, fluorimetry, nephelometry and flame photometry will be subjects of the second week.

Tuition for each week will be $50.

Zinc Institute Will Meet on April 11-12

Sessions of the 32nd annual meeting of the American Zinc Institute are scheduled to be held at Hotel Statler, St. Louis, April 11 and 12.

Items of corrosion interest include: "Galvanized Products in the Farm Market," by F. J. Reynolds, Carnegie-Illinois Steel Corp.; "Zinc in Die Castings," by R. G. Kenly, The New Jersey Zinc Sales Co. A talk on "Developments in Galvanizing," will be given by a qualified speaker.

Hot Dip Galvanizers' New Officers Elected

Elected by the American Hot Dip Galvanizers' Association during its fifteenth annual meeting at Cincinnati, Ohio, were the following members of the board of directors: R. E. Byrd, Atlantic Steel Co., Atlanta, Ga.; C. L. Moorman, Equipment Steel Products Co., Blue Island, Ill. and P. B. Coombs, Riverside Foundry & Galvanizing Co., Kalamazoo, Mich. Mr. Byrd was elected president.

Acetylene Meeting

Members of the International Acetylene Association held their 1950 convention March 27-29 at San Francisco, Cal. Eight technical papers in three sessions were scheduled.

Additional Copies of Austin Short Course Lectures Are Considered

The last of eight papers covering nine lectures given during the 1949 Short Course in Corrosion at the University of Texas, Austin, September 12-16, 1949 has been received by Central Office NACE for reproduction. Work of reproducing the paper already has begun.

The last paper to be received was that covering the lecture by E. A. Prange of Phillips Petroleum Co., Bartlesville, Okla. on metallurgy. This paper, together with that by L. G. Vande Bogart of Crane Company on types of corrosion which already has been reproduced, will be distributed to those who received the first six papers. No other automatic distribution is contemplated.

Plans are under way however, if demand justifies it, to reproduce all the eight papers and offer them as a collected book at nominal cost. Decision on this will be made in the next few weeks. Those who have inquired about the possibility of obtaining copies of these lectures, or who wish to obtain copies now may write for information to A. B. Campbell, Executive Secretary, NACE.

•

The Managing Editor of CORROSION magazine always is happy to see photographs considered suitable as subjects for the covers of the magazine. Address such photographs together with descriptive captions and release for the use to Central Office.

MEET ME IN ST. LOUIS
YOU ARE CORDIALLY INVITED TO VISIT OUR BOOTH (NO. 56) AND SEE A COMPLETE LINE OF METER INSULATION . . .
and in particular, our S.E.I. NUT
THE SAFEST, CHEAPEST OF ALL METER INSULATION.
1950 N.A.C.E. CONFERENCE
JEFFERSON HOTEL — ST. LOUIS
APRIL 4, 5, 6, & 7
SERVICE ENGINEERS, INC.
FIRST NATIONAL BANK BLDG.
FORT WORTH, TEXAS

Corrosion Problems

Questions and answers for this heading should be submitted in duplicate if possible, addressed to "CORROSION PROBLEMS", National Association of Corrosion Engineers, 919 Milam Building, Houston 2, Texas. Questions received at the address above will be sent to E. A. Tice, The International Nickel Co., Inc., N. Y., who is acting editor of the page. All questions will become property of NACE. Questions and replies may or may not be published under this heading and may be answered either by mail directly to the person asking the information, or published under this heading, or both, at the discretion of the editorial staff. Answers to published questions are solicited. Authors of questions will remain anonymous to readers, while authors of answers may remain anonymous if they request it.

No. 46—In the chemical industry what use has been made of cathodic protection, particularly by impressed current, in overcoming corrosion problems in processing equipment?

No. 47—Does the use of formaldehyde as an inhibitor of corrosion have any application in petroleum refineries?

No. 48—For sodium hydride descaling of steel have there been any corrosion failures of steel tanks or heat exchanger surfaces?

Does steel equipment have to be annealed in order to prevent caustic imbrittlement?

No. 49—Can anyone cite cases of stress corrosion cracking of stainless steels used for heat exchanger service wherein hot brackish water is known to be the media causing the cracking?

No. 50—A viscous fuel oil, containing about 3% sulfur, is to be pumped through a pipe line for a considerable distance. To keep it warm enough to flow, a one-inch steam line handling steam at 300 to 350° F will be installed within the pipe line, which is made of steel.

There may be some caustic soda entrained in the fuel oil. Can steel piping be expected to have satisfactory corrosion resistance for use as the steam line, or must an alloy be used. If so, what material is recommended.

We Want Your Answers To Corrosion Problems

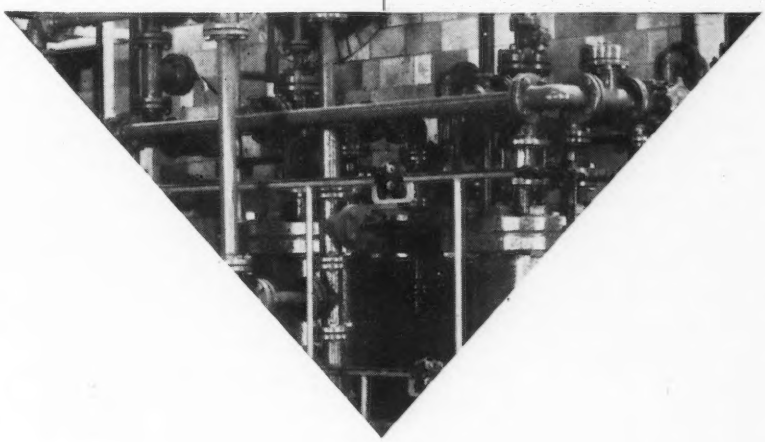
Replies to questions under this heading are solicited by NACE. Tables, graphs and illustrations necessary for a full answer are welcomed. Address your answer to NACE Central Office, giving the question number. Early publication of answers is proposed.

Diffusion to Be Topic

Diffusion will be the topic of the American Society for Metal's 1950 seminar, October 21-22, 1950 at Chicago's International Amphitheater. Sponsoring the 1950 Metal Congress and Exposition, in addition to ASM, will be the American Welding Society, Metals Branch — AIMME and Society for Non-Destructive Testing.

SARAN LINED steel pipe

cuts repairs and replacements to a minimum!



The conveyance of corrosive liquids can prove as hard on profits as it is on equipment. It's this realization that has compelled more plants than ever before to install corrosion-resistant saran lined steel pipe. Saran's resistance to most chemicals and solvents reduces shutdowns and lost production! Saves time and labor!

Saran lined steel pipe is available in maximum lengths of 10 feet and in sizes from 1 to 6 inches inclusive. Also available are saran lined diaphragm valves, plug valves, flanges, reducing flanges, flanged fittings, gaskets and fittings with union ends.

Write us today for further information concerning saran lined steel pipe and how it may help solve your corrosion problems. Manufactured by The Dow Chemical Company, Bay City, Michigan, distributed by Saran Lined Pipe Company, Dept. TSP-19.

Distributed by

Saran Lined Pipe Company

701 STEPHENSON BUILDING • DETROIT, MICHIGAN

Offices in: New York • Boston • Philadelphia • Pittsburgh Chicago • Tulsa • Indianapolis • Houston • San Francisco Los Angeles • Portland • Cleveland • Denver • Seattle Charleston, S. C. • Toronto

SARAN LINED PIPE a DOW product

HEAT FUMES } A TOUGH CORROSIVE TEAM TO BEAT . . .

You can do it with DAMPNEY SILICONE Coating Aluminum

Try this material *first* if you would not be deploring, several failures hence, the apparent lack of a protective coating to meet your standards for fume-resistant surfacing to 750°F.

Not just another aluminum-pigmented paint, Dampney Silicone Coating contains resins sufficient in quantity to impart to it all of the unique heat stability, low moisture absorption and exceptional durability of silicones.

Wherever metal is exposed to continuous heat, or to intermittent heating and chilling — in heavily fume-contaminated atmospheres either sheltered or under severe weather exposure — Dampney Silicone Coating will keep it securely corrosion-free longer.

That it does so at a cost no greater in terms of material, labor and equipment down-time than you may now be paying for considerably less resultful performance is a plus value to be realized in this product of Dampney Maintenance for Metal.

When you have all the facts about Dampney Silicone Coating, we believe you'll want us to quote on your specific applications. Why not give us the details now – when you're writing for Bulletin 1570.

100-1 MAINTENANCE FOR METAL

THE DAMPNEY COMPANY OF AMERICA

HYDE PARK, BOSTON 36, MASS.

NACE

NEW AND REINSTATED

MEMBERS

AND ADDRESS CHANGES

NEW AND REINSTATED MEMBERS

(Changes Through February 28, 1950)

CALIFORNIA

ENDERS, ROGER S., The Hancock Oil Co. of California, Box 810, Long Beach, California.

MARKHAM, WENDELL G., International Cementers, Inc., 6505 Paramount Blvd., Long Beach 5, California.

RASOR, JOHN P., Tinker & Rasor, P. O. Box 281, San Gabriel, California.

WILLIAMS, LUTHER F., Southern Pacific Co. (RR), 65 Market St., San Francisco, California.

YEATMAN, C. A., Shell Oil Co., 1008 West Sixth St., Los Angeles 5, California.

DISTRICT OF COLUMBIA

HARWOOD, JULIUS J., Office of Naval Research, Navy Dept., Washington, D. C.

FLORIDA

COOPER, GEORGE E., Cooper Brothers, Painters & Decorators, 868 N. E. 119th St., Miami 38, Florida.

ILLINOIS

HARNSBERGER, A. E., The Pure Oil Co., 35 E. Wacker Dr., Chicago 1, Illinois.

KARGER, FRANK S., 222 East Chestnut St., Chicago 11, Illinois.

ROHWEDDER, JOHN L., U. S. Corps of Engineers, Clock Tower Bldg., Rock Island, Illinois.

KANSAS

BARB, MELVIN V., Socony-Vacuum Oil Co., Inc., 917 1st Nat'l Bank Bldg., Wichita, Kansas.

HATCHETT, V. W., Socony-Vacuum Oil Co., Augusta, Kansas.

SANDERS, IRVIN C., Sinclair Refining Co., Sinclair Bldg., Independence, Kansas.

LOUISIANA

WYMAN, JOHN D., Cities Service Refining Corp., Tutwiler Refinery, Lake Charles, Louisiana.

MARYLAND

BIALECKI, ADOLPH, U. S. Industrial Chemicals, Inc., Research Laboratories, Box 1983, Baltimore 3, Maryland.

MICHIGAN

HEDGES, EUGENE B., Michigan Gas Storage Co., P. O. Box 1051, Saginaw, Michigan.

MINNESOTA

BENSON, C. A., Northwestern Bell Telephone Co., 224 South Fifth St., Minneapolis, Minnesota.

MISSOURI

BAKER, EDWARD L., 22 So. Elm Ave., Webster Groves 19, Missouri.

EBERT, RAYMOND E., Fairbanks, Morse & Co., Westco Works, 4301 S. Spring Ave., St. Louis 16, Missouri.

NEW JERSEY

EBERHARDT, T. J., Subox, Inc., Fairmount Plant, Hackensack, New Jersey.

JORCZAK, JOSEPH S., Thiokol Corp., 780 North Clinton Ave., Trenton, New Jersey.

MacCORMACK, ROBERT S., Jr., Stevens Institute of Technology, 5th St. and Hudson St., Hoboken, New Jersey.

NEW YORK

BEACHAM, EDWARD A., JR., General Electric Co., 1 River Rd., Schenectady, New York.

EVES, W. D. HEATH, Anglo-Iranian Oil Co. Ltd. 610 Fifth Ave., New York 20, New York.

GODFREY, JOHN W., General Motors Corp., Harrison Radiator Div., Lockport, New York.

KLUMB, HARVEY J., Rochester Gas & Electric Corp., 89 East Ave., Rochester 4, New York.

LANG, FRANCES S., Atomic Energy Commission, New York University, Washington Square, New York New York.

PETERS, WILBUR RALPH, JR., Central Hudson Gas & Electric Corp., South Rd., Poughkeepsie, New York.

OHIO

BAKER, WILLIAM E., Standard Oil Co. (Ohio), 600 Standard Bldg., Cleveland, Ohio.

ELDER, LOWELL L., Columbia Engineering Corp., 99 N. Front Columbus, Ohio.

HENDERSON, OLIVER, The Ohio Bell Telephone Co., Electric Bldg., 700 Prospect Ave., Cleveland 15, Ohio.

NORD, G. L., Schauer Mfg. Co., 2060 Reading Rd., Cincinnati 2, Ohio.

SICHA, WALTER E., Aluminum Co. of America, 2210 Harvard Ave. Cleveland, Ohio.

STONE, JAMES MORRISON, Ohio State University, Metallurgy Dept., Eng. Exp. Station, Columbus, Ohio.

OKLAHOMA

BROWN, H. D., Stanolind Oil Purchasing Co., P. O. Box 591, Tulsa, Oklahoma.

DANNE, HERBERT J., Pipeline Maintenance Corp., 811 So. Boulder, Tulsa, Oklahoma.

LIMA, D. O., Oklahoma Gas & Electric Co., 321 No. Harvey, Oklahoma City 1, Oklahoma.

MASON, JOHN R., Stanolind Oil Purchasing Co., P. O. Box 591, Tulsa, Oklahoma.

PENNSYLVANIA

BYARRE, WM. W., The Atlantic Refining Co., 260 So. Broad St., Philadelphia 2, Pennsylvania.

LEPLEY, RAYMOND D., The Atlantic Refining Co., 260 So. Broad St., Philadelphia 2, Pennsylvania.

TEXAS

AGERTON, WILLIAM D., Sinclair Refining Co., Pipe Line Dept., 901 Fair Bldg., Fort Worth, Texas.

BELL, LEO A., The Dia-Log Co., Box 3047 Odessa, Texas.

CONNORS, WILLIAM F., Humble Oil & Refining Co., P. O. Box 2180, Houston, Texas.

HUDSON, WILLIS I., Hudson Chemical Products, 431 Kress Bldg., Houston, Texas.

JOYCE, EDWIN American Petroleum Institute, 1205 Continental Bldg., Dallas 1, Texas.

M SCOPE

PIPE AND CABLE FINDER

Type 49AB

Supplied in Metal Cased Cabinets

$149.50

tells you where and how deep

Weight . . . . 10 lbs.

Can be used to advantage over highly conductive ground

FISHER RESEARCH LABORATORY INCORPORATED

Palo Alto California

LOCHEED, E. W., American Republics Corp., Petroleum Bldg., Houston 2, Texas.
PIERCE, E. K. TED, The Wm. Powell Co., 329 West Bldg., Houston 2, Texas.
SELLERS, H. P., American Republics Corp., Petroleum Bldg., Houston 2, Texas.

VIRGINIA

WALLACE, ROBERT P., Jamestown Road, Williamsburg, Virginia.

WISCONSIN

AMUNDSON, ROALD H., Line Material Co., 2201 12th Ave., South Milwaukee, Wisconsin.

FOREIGN

MAW, J. T., Andian National Corp., Ltd. Cartagena, Colombia, South America.
DOBBS, CECIL I., Creole Petroleum Corp., Corrosion Control Section, Cabimas, Estado Zulia, EE. UU. de Venezuela.
MADDIGAN, S. E., British Columbia Research Council, Vancouver B. C., Canada.
TAMEZ, OSCAR VAZQUEZ, Petroleos Mexicanos, Apdo. Postal No. 161, Tampico, Tam., Mexico.
YORATH, D. K., Northwestern Utilities, Ltd., 10124 - 104th St., Edmonton, Alberta, Canada.

CHANGES OF ADDRESS

(Old Address Follows New Address in Parenthesis)

Following is a correct listing for one published in the February issue under this same heading, same state:

ILLINOIS

LANE RUSSELL W., Illinois State Water Survey, Box 232, Urbana, Ill. (National Aluminate Corp., 3615 N. Colorado Ave., Indianapolis, Ind.)

ARKANSAS

BERTETTI, J. W., Pan Am Southern Corp., P. O. Box 791, El Dorado, Arkansas (Root Petroleum Co., El Dorado, Arkansas).

CALIFORNIA

BARCUS, E. DALE, Pacific Tele. & Tel. Co., 740 S. Olive St., Rm. 816, Los Angeles 55, California (Pacific Tele. & Tel. Co., 740 S. Olive St., Rm. 823 Los Angeles 55, California).
DEGENHART, THURLO E., Mare Island Naval Shipyard, Bldg. 47, Public Works Design, Vallejo, California (Mare Island Naval Shipyard, Bldg. 47, Vallejo, California).
DORSEY, JOSEPH S., 1216 No. La Presa Drive, San Gabriel, California (Southern California Gas Co., 1700 Santa Fe, Los Angeles, California).
GALLAGHER, JOHN S., 1037 Burnside Avenue, Los Angeles 19, California (1037 Burnside Avenue, Los Angeles 35, California).
LACY, J. GLEN, Amercoat Corp., 4809 Firestone Blvd., South Gate, California (American Pipe & Const. Co., Amercoat Divn., 4809 Firestone Blvd., South Gate California).
SCHLAUDT, CLARENCE A., Box 393, Trona, California (American Potash & Chemical Corp., Trona, California).
SCOTT, GORDON N., Richfield Bldg., 555 So. Flower St., Los Angeles 17, California Richfield Bldg., 555 So. Flower St., Los Angeles 13 California).
SMITH, CLAUDE B., Ceilcote Co. & Wm. F. Klemp Co., Inc., 200 Davis St., San Francisco 11, California (Ceilcote Co. & Wm. F. Klemp Co., Inc., 615 Sansome St., San Francisco 11, California).
STAUFFACHER, E. R., So. Calif. Edison Co., P. O. Box 351, Los Angeles 53, California (So. Calif. Edison Co., Ltd., P. O. Box 351, Los Angeles 53, California).
STORM, ARTHUR E., Tide Water Assoc. Oil Co., Associated, California (STORM, ARTHUR E., Tide Water Assoc. Oil Co., Avon, California).
WACHTER, AARON Attn: Librarian, Shell Development Co., 4560 Horton St., Emeryville 8, California (Shell Development Co., 4560 Horton St., Emeryville 8, California).

GEORGIA

SULLIVAN, DAVID N., Electro Rust-Proofing Corp. (N. J.), 1375 Normandy Dr. N. E., Atlanta, Georgia (Electro Rust-Proofing Corp. [N. J.], 1314 Piedmont Ave., N. E. Atlanta, Georgia).

ILLINOIS

FOELSCH, HENRY W., Stalpic Coating Corp., 2310 S. Indiana Ave., Chicago 16, Illinois (Stalpic Coating Corp., 1128 W. Armitage Ave., Chicago 14, Illinois).
LANE, RUSSELL W., Illinois State Water Survey, P. O. Box 232 Urbana, Illinois (P. O. Box 232, Urbana, Illinois).
MILLER, HARRY J., Amercoat Corp., 4554 N. Broadway, Chicago 40, Illinois (Amercoat Div. American Pipe & Const. Co., 4554 N. Broadway, Chicago 40, Illinois).
OLSON, THEODORE W., R.F.D. 4, Geneseo Illinois (Natural Gas Pipeline Company of America, Box 486, Beatrice, Nebraska).
PERRY, RUSSELL I., Commonwealth Edison Co., 72 W. Adams St., Room 818, Chicago 90, Illinois (Commonwealth Edison Co., 72 W. Adams St., Room 718 Chicago 90, Illinois).
PHILLIPS, EDWIN H., 435 North Lombard Ave., Oak Park, Illinois (Western Union Telegraph Co., 435 North Lombard Ave., Oak Park, Illinois).
STEFANIDES, VICTOR N., 6509 Oshpori Ave., Chicago 31, Illinois (Illinois Tool Works, 2501 Keeler Ave., Chicago 39 Illinois).
TRISSAL, J. M., Illinois Central R. R. Co., Rm. 706, 135 E. 11th Place, Chicago 5, Illinois (Illinois Central R. R. Co., Rm. 900, 135 E. 11th Place, Chicago 5, Illinois).
WATERBURY, C. L., Roadway Equipment & Welding, C. M. St. P. & P. RR. Co. 898 Union Station, Chicago 6, Illinois (Chicago, Milw., St. Paul, & Pac. RR. Co., 898 Union Station, Chicago 6, Illinois).
ZIPPER, DONALD H., White Cap Co., 1819 N. Major, Chicago 39, Illinois (Armour Research Foundation 35 W. 33rd St., Chicago 16, Illinois).

INDIANA

PAYNE, PAUL P., Dearborn Chemical Co., 501 Chamber of Commerce Bldg., Indianapolis 4, Indiana (Dearborn Chemical Co., 510 Chamber of Commerce Bldg., Indianapolis 4, Indiana).
RAMIREZ, E., General American Transportation Corp., Research & Testing Laboratories, East Chicago, Indiana (RAMIREZ ERNEST P., ING., Graduate School, Illinois Institute of Technology, Chicago 16, Illinois).

IOWA

DOUGHERTY, WM. J., Iowa Public Service Co., 502 6th St., Sioux City 4, Iowa (Iowa Public Service Co., 515 5th St., Sioux City 4 Iowa).

KANSAS

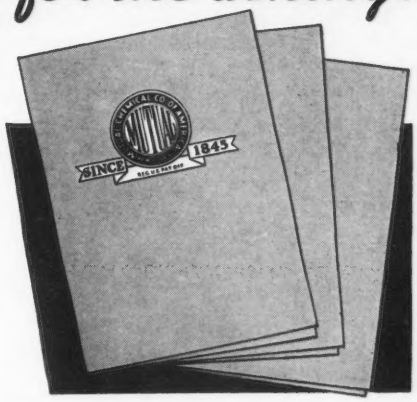
BLISH, ERVIN R., 501 N. Spring Lake, Meade, Kansas (Northern Natural Gas Co., Aquila Court Bldg., Omaha, Nebraska).

LOUISIANA

GRAVES, R. W., Triangle Pipeline Co., P. O. Box 1795, Shreveport, Louisian (Triangle Pipeline Co., P. O. Box 1695, Shreveport Louisiana).

YOURS-*for the asking!*

Mutual's Booklets on CHROMATES



Mutual Chemical Company has available a wide list of pamphlets describing applications in which chromates have been used effectively in various industries. Listed below are four of the newest booklets which are available without obligation.

MUTUAL CHEMICAL CO. OF AMERICA
270 Madison Ave., New York 16, N. Y.

Please send me a free copy of the pamphlets checked below:

- ☐ Serial No. 33—"Chromate Corrosion Inhibitors for Internal Combustion Engines."
- ☐ Serial No. 53—"Corrosion Inhibitors in Recirculating Water Systems."
- ☐ Serial No. 55—"Corrosion Inhibition with Chromate" (In the Oil and Gas Industries).
- ☐ Serial No. 56—"Properties of Technically Important Hexavalant Chromium Compounds."

Name_____

Company_____

Address_____

City_____ State_____

CO

PICARAZZI, JOSEPH J., 1908 Woodruff St., Lake Charles, Louisiana (417 Burnett St., Lake Charles, Louisiana).

STANTON, W. L., Texas Gas Transmission Corp., Box 1840, Shreveport, Louisiana (Carthage Field Engr. Committee, Box 312, Carthage Texas).

MARYLAND

MILLER, W. S., Mathieson Bldg., Baltimore, Maryland (BENNETT, A. T., Mathieson Chemical Corp., 60 East 42nd St., New York 17, New York).

MICHIGAN

FIEDELMAN, HOWARD W., Chief Chemist, Morton Salt Co., Manistee, Michigan (Chief Engineer Morton Salt Co., Manistee, Michigan).

HUMBLE, H. A., The Dow Chemical Co., Cathodic Protection Sales Dept., 1-47 Bldg., Midland, Michigan (The Dow Chemical Co., Cathodic Protection Sales Dept., Midland Michigan).

McCLINTOCK, ROBT. D., Michigan-Wisconsin Pipe Line Co., 500 Griswold St., Detroit 25, Michigan (Colorado Interstate Gas Co., Box 1087, Colorado Springs, Colorado).

SCHMIDT, HERBERT W., 1313 Helen St., Midland, Michigan (Dow Chemical Co., 1313 Helen St., Midland, Michigan).

MISSOURI

ZANGE MAX, c/o Warwick Hotel, St. Louis 3, Missouri (c/o Warwick Hotel, St. Louis, Missouri).

NEBRASKA

LARSEN, ROBERT L., Ohio Oil Co., P. O. Box 651, Sydney, Nebraska (Ohio Oil Co., P. O. Box 548, Rawlins, Wyoming).

NEW JERSEY

BLAKE, GEORGE H., Public Service Elec. & Gas Co., 80 Park Place, Newark 1, New Jersey (Public Service Corp. of N. J. 80 Park Place, Newark 1, New Jersey).

CROBAUGH, ALBERT O., Rocket Dept., Curtiss-Wright Corp., Propeller Div., Caldwell, New Jersey (Rockett Dept., Curtiss-Wright Corp., Propeller Div., Caldwell, New Jersey).

FAIR, W. F., JR., 704 Springfield Ave. Cranford, New Jersey (Mellon Institute, Fifth Ave., Pittsburgh, Pennsylvania).

POPE, ROBERT, Bell Telephone Lab., Murray Hill, New Jersey (Bell Telephone Lab. 463 West St., New York 14, New York).

RICHARD, CHARLES S. 268 Manning Ave. North Plainfield, New Jersey (2608 Manning Ave., North Plainfield, New Jersey).

SHENTON, F. GEORGE, Research & Development Labs., Socony-Vacuum Oil Co., Inc., Paulsboro, New Jersey (SHENTON, FRANCES G., Research & Development Labs., Socony-Vacuum Oil Co., Inc., Paulsboro New Jersey).

STUART, LINDEN, JR., 970 Hillside Ave., Plainfield, New Jersey (The Barrett Division, 40 Rector St., New York, New York).

NEW YORK

EVANS, CLAIR O., Phelps Dodge Copper Products Corp., 40 Wall St., 43rd Floor, New York 5 New York (Phelps Dodge Copper Products Corp., 6100 Garfield Ave., Los Angeles 22, California).

FLENTJE, MARTIN E., American Water Works Service Co., 50 Broad St., New York 4, New York (American Water Works Co., 50 Broad St., New York 4, New York).

HEALEY, EDWARD LEWIS, 269 Candee Ave., Sayville, New York (California Texas Oil Co. Ltd., 551 Fifth Ave., New York 17 New York).

McCULLOUGH, HAROLD M., Sylvania Electric Products, P. O. Box 6, Bayside, Long Island, New York (Sylvania Electric Products, 149-49 22nd Ave., Flushing, New York).

MOE, JOHN L., 144-35 Roosevelt Ave., Flushing, L. I., New York (Ebasco Services, Inc. 2 Rector St., New York 6, New York).

PRIESTLEY, HENRY L., Electro Metallurgical Div., Union Carbide & Carbon Corp., 30 East 42nd St., New York, New York (Electro Metallurgical Co., 30 East 42nd St., New York, New York).

TAYLOR, R. D. Federated Metals Division, American Smelting & Refg. Co., 120 Broadway, New York, New York (Federated Metals Division, American Smelting & Refg. Co., 1160 State St., Barber, New Jersey).

OHIO

ENGLE, J. PRESTON, 1011 Parkside Dr., Alliance, Ohio (Babcock & Wilcox Res. & Dev. Dept., Harrisburg & Sawburg Roads, Alliance Ohio).

OLIVER, J. PAUL, National Carbon Division, Union Carbide & Carbon Corp., P. O. Box 6087, Cleveland 1, Ohio (P. O. Box 6087, Cleveland 1, Ohio).

PLOEDERL, FRANCIS J., Permolite, Inc., North 5th and Ford Blvd., Hamilton, Ohio Permolite Divn. Cyclic Chemical Co., No. 5th and Ford Blvd. Hamilton, Ohio).

THOMAS, ARBA H., c/o Research Library, Armco Steel Corp., 703 Curtis, Middletown, Ohio (Armco Steel Corp., 703 Curtis, Middletown, Ohio).

VANDAVEER, F. E., Director of Laboratories, The East Ohio Gas Co., 1405 East 6th St. Cleveland 14, Ohio (Chief Chemist The East Ohio Gas Co., 1405 East 6th St., Cleveland 14, Ohio).

OKLAHOMA

BIDDISON, P. McDONALD, 212 Beacon Bldg., Tulsa 3, Oklahoma (135 South LaSalle St., Chicago 3, Illionis).

BRADY, HUGH A., Gulf Refg. Co., Tulsa Pipe Line Div., Gulf Bldg., Tulsa 2 Oklahoma (Gulf Refg. Co., Tulsa Pipe Line Div., First National Bank Bldg., Tulsa 2, Oklahoma).

BULLOCK, ROBERT L., Interstate Oil Pipe Line Co., P. O. Box 1349, Tulsa 2, Oklahoma (Interstate Oil Pipe Line Co., P. O. Box 1349, Tulsa, Oklahoma).

CALLAHAN, MELVIN C. Gulf Refg. Co., Tulsa Pipe Line Div., Gulf Bldg., Tulsa 2 Oklahoma (Gulf Refg. Co., Tulsa Pipe Line Div., First National Bank Bldg., Tulsa 2, Oklahoma).

STIRLING, J. C., Stanolind Pipe Line Co., Box 1979, Tulsa, Oklahoma (Stanolind Pipe Line Co., Box 591, Tulsa Oklahoma).

OREGON

GOW, JAMES T., 01015 S. W. Palatine Hill Rd., Portland 1, Oregon (01015 S. W. Palestine Hill Rd., Portland 1, Oregon).

PENNSYLVANIA

BOWDEN, RAYMOND C., JR., 327 Craft Ave., Pittsburgh 13, Pennsylvania (National Tube Co., Research Lab., 4919 Forbes St. Pittsburgh, Pennsylvania).

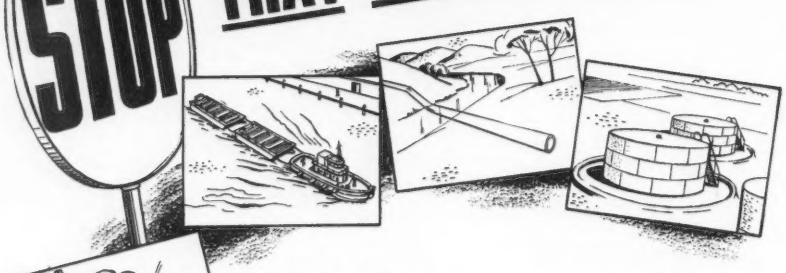
COLLINS, HARRY, Metallizing Engineering Co., Inc., 1500 Walnut St., Philadelphia 2, Pennsylvania (Metallizing Engineering Co., Inc., 38-14 30th St., Long Island City, New York).

DEICHLER, J. K., Mechanical Inspection Dept. The Atlantic Refining Co., Ref. Div., 3144 Passyunk Ave., Philadelphia, Pennsylvania (Asst. Ch. Insp., Mechanical Inspection Dept., The Atlantic Refining Co. Ref. Div., 3144 Passyunk Ave., Philadelphia, Pennsylvania).

CPS HAS THE MATERIALS . . . KNOW-HOW . . . FACILITIES

TO . . .

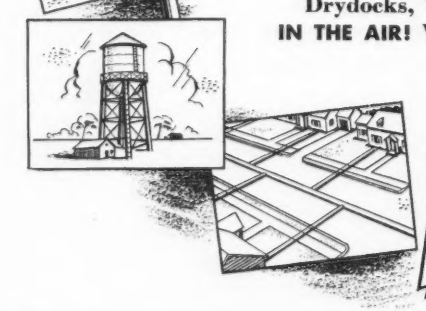
STOP THAT CORROSION!



ON LAND! Pipelines, Tank Bottoms, Gathering Systems, Gas & Water Distribution Systems

*ON SEA! Offshore Drilling Platforms, Offshore Pipe Lines, Wharves, Piers, Ships, Barges, Drydocks, Wellheads

IN THE AIR! Water Tanks, Condenser Heads



CPS OFFERS A complete sales, engineering and installation service

1. FIRST LINE MATERIALS
2. YEARS OF "KNOW-HOW"
3. COMPLETE FACILITIES

CPS handles only first line materials made by famous well known manufacturers. DOWELL Magnesium Anodes — GENERAL ELECTRIC Rectifiers — MALONEY Insulating Materials —M-SCOPE Pipe and Cable Finders — CADWELL Welding Supplies — RUBICON Potentiometers—Soil Resistivity Apparatus—HOLLOWAY Shunts—Miscellaneous instruments.

* These structures are usually protected most economically by a combination of CATHODIC PROTECTION and the ELECTRO-COATING PROCESS to which CPS holds exclusive license under U. S. Patent Numbers 2,200,469 and 2,417,064.

CATHODIC PROTECTION SERVICE

HOUSTON, TEXAS
4601 Stanford
Phone JA-5171

CPS

TULSA, OKLAHOMA
310 Thompson Bldg.
Phone 2-9857

Everything in the Cathodic Protection Field from an Insulating Washer to a Turnkey Contract Installation

BARRETT* PROTECTIVE PRODUCTS
COVER EVERY PIPE-COATING NEED

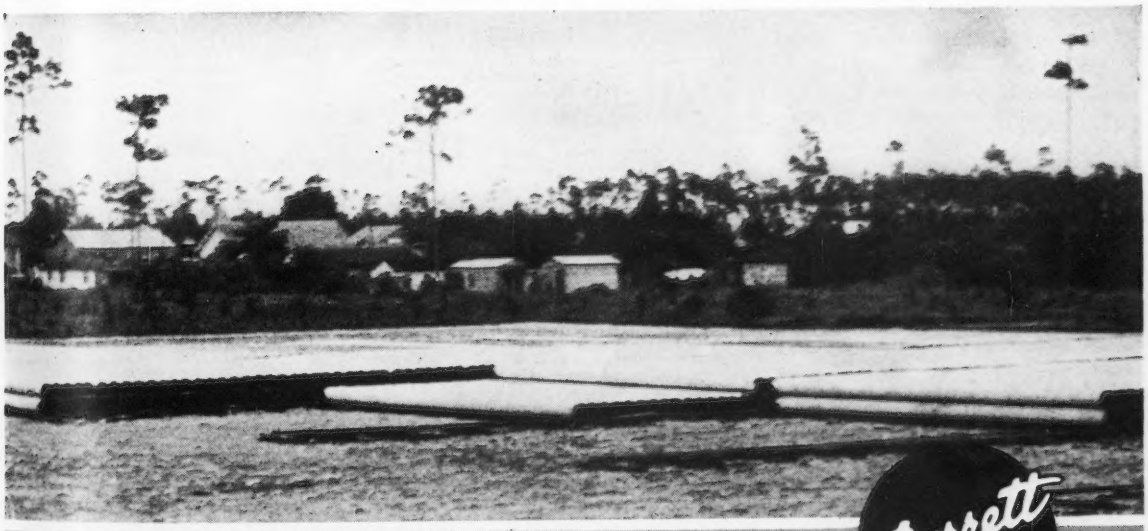
1 Pipeline Enamel
2 Millwrap Enamel
3 A.A. Enamel
4 Asbestos Felt
5 Materials for Special Uses

BARRETT* MILLWRAP ENAMEL

Like other Barrett* coal-tar enamels, Barrett* Millwrap Enamel is non-absorbent and impermeable by soil waters. Because of its stability when exposed to the surrounding electrolyte consisting of the entire soil composition, it retains its high electrical insulation value.

A permanent, strong, flexible shield protecting the pipe from corrosion, Barrett Millwrap Enamel is recommended for its ease of application and satisfactory performance. It combines the best service characteristics of the Barrett refined coal-tar pitches used in producing both regular and plasticized enamels. It does not crack at 0° F.; nor flow at 140° F.

Barrett Millwrap Enamel has demonstrated its ability to protect underground lines in extremely corrosive locations. It is also outstanding in its ability to withstand stockpile exposures before the pipe is laid, as well as exposure normal to pre-coated pipe protected at coating plants, yards, or railhead locations.



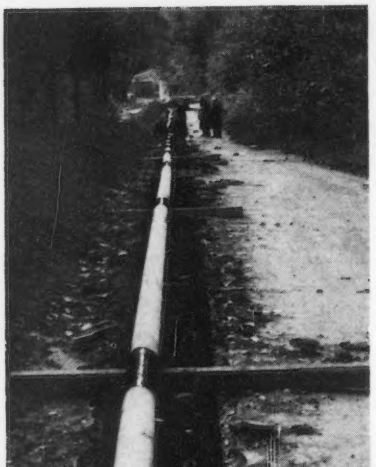
Barrett*

Memo: FOR CORROSION ENGINEERS

Barrett coal-tar materials for special uses are all dependable, durable and economical. Eternium* Paint for exposed metal work. CA-50 Heavy Duty Cold Application Coating for concrete and metal exposed to extremely corrosive conditions. Marine Enamel for ships, barges and off-shore service vessels. Service Cement and Pipeline Fabric for field joints — no torching required. Asbestos Pipeline Felt for soil stress shield. Tank Bottom Compound for sour crude storage. 34 YB Paint for exposure to salt water spray conditions.

THE BARRETT DIVISION
ALLIED CHEMICAL & DYE CORPORATION
40 Rector Street, New York 6, N. Y.

*Reg. U. S. Pat. Off.



It Pays to Specify

TAPECOAT

. . . The Modern Protection for Pipe Joints, Service Connections, Mechanical Couplings, Large Bends and Large Diameter Pipe

TAPECOAT . . . the *coal tar* wrapping in handy tape form is the practical answer to engineers in solving many corrosion problems. Available in widths from 2" to 24", it's the one handy coating you can use right down the line from the smallest to the largest jobs and provide protection equivalent to the mill coating on the pipe. It's easy to apply TAPECOAT. The small widths are spirally wrapped . . . the large widths are cigarette-wrapped. No dirt. No mess. You save time, work, material and money.

Write for details or ask for demonstration

*Reg. U.S. Pat. Off.

The TAPECOAT Company
1523 Lyons Street . Evanston, Illinois
New York Office
469 Fifth Ave., New York 17, N. Y.
Houston Office
Jas. E. Mayor Co.
514 M & M Bldg., Houston 2, Texas
Denver Office
175 Niagara St., Denver 7, Colo.

LARRABEE, C. P., Research Lab., Carnegie-Illinois Steel Corp., Vandergrift, Pennsylvania (Corrosion Research Lab., Carnegie-Illinois Steel Corp., Vandergrift Penn).

LAWLOR, E. W., Pittsburgh Coke & Chemical Co., Grant Bldg., Pittsburgh, Pennsylvania (Pittsburgh Coke & Chemical Co., Neville Island, Pittsburgh 25, Pennsylvania).

PEIFER, RICHARD H., 81 Valleyview Dr., R. D. No. 2 Library, Pennsylvania (Richard H. Peifer Co., Corrosion Serv. 1801 Ellsworth Ave., Carnegie P. O., Heidelberg, Pennsylvania).

RINGER, FRANCIS, Texas Eastern Transmission Corp., P. O. Box 32, Downington, Pennsylvania (Texas Eastern Transmission Corp., P. O. Box 4, Uwchland, Pennsylvania).

ROMIG, O. E., Carnegie-Illinois Steel Corp. 234 Atwood St., Pittsburgh 13, Pennsylvania (Carnegie-Illinois Steel Corp., 324 Atwood St., Pittsburgh 13, Pennsylvania).

STOERTZ, HOWARD, Electric Storage Battery Co., 19th St. and Allegheny Ave., Philadelphia 32, Pennsylvania (Electric Storage Battery Co., 19th St. & Allagheny Ave. Philadelphia 32, Pennsylvania).

VIELE, S. M., 450 Strath Haven Ave., Swarthmore, Pennsylvania (450 Strath Haven Ave., Swarthmore, Pennsylvania).

TEXAS

ALLEN, HENRY W., Cathodic Protection Service, 4601 Stanford, Houston 6, Texas (Cathodic Protection Service, 1801 Bissonnet, Houston, Texas).

CRENSHAW, WILLIAM H., American Inspection Service, Box 789, Midland, Texas (American Inspection Service, Midland Air Terminal, Box 789, Midland, Texas).

CROWE, RAYMOND H., Stone & Webster Service Corp., 905 M & M Bldg. Houston 2, Texas (Stone & Webster Service Corp., 901 M & M Bldg., Houston 2, Texas).

DOREMUS, E. P., Cathodic Protection Service, 4601 Stanford, Houston 6, Texas (Cathodic Protection Service, 1801 Bissonnet, Houston 2, Texas).

DOREMUS GORDON L., Cathodic Protection Service, 4601 Stanford, Houston 6, Texas (Cathodic Protection Service, 1801 Bissonnet, Houston, Texas).

FORBES, M. C., Aquatrol, Inc., Box 12233, Houston 17 Texas (Aquatrol, Inc., P. O. Box 12206, Houston 17, Texas).

GRIFFITH, DEAN O., 2414 Delafield St., Houston, Texas (Shell Pipe Line Corp., Box 318, Houston, Texas).

HARRIS, JACK W., Cameron Iron Works, Inc., P. O. Box 1212 Houston 1, Texas (Cameron Iron Works, Inc., P. O. Box 1212, Houston, Texas).

HESS, FRED E., Fred E. Hess, Inc., 1410 Fort Worth National Bank Bldg., Forth Worth 2, Texas (Fred E. Hess, Inc., 2212 Fort Worth National Bank Bldg., Fort Worth 2, Texas).

IRWIN, C. A. Rio Grande Valley Gas Co., P. O. Box 391, Brownsville, Texas (Rio Grande Valley Gas Co., 5th and Elizabeth, Brownsville, Texas).

KLEESPIES, HENRY S., JR., 5237 32nd St., Port Arthur, Texas (Gulf Oil Corp., 7th St. Rd., Port Arthur, Texas).

LEDBETTER, BUFORD P. Gas Dept. City of Corpus Christi, Box 1622, Corpus Christi, Texas (Gas Dept. City of Corpus Christi, Box 111, Corpus Christi, Texas).

LOMAX, O. Q., Vice-Pres., Humble Pipe Line Co., 1216 Main St., Houston 2, Texas (V. P. & Gen. Supt., Humble Pipe Line Co., 1216 Main St., Houston 2, Texas).

McCALL, RICHARD H. The Texas Co., Box 72, Liberty, Texas (The Texas Co., Drawer 2, Pearland, Texas).

PARKER, MARSHALL E., JR., Cathodic Protection Service, 4601 Stanford, Houston 6, Texas (Cathodic Protection Service, 2023 Jean Houston 3, Texas).

POLLOCK, BILL, Southern Pipe Line Corp., P. O. Box 716, Corpus Christi, Texas (Southern Pipe Line Corp., 411 N. Broadway, Corpus Christi, Texas).

RICE, WILLIAM R., Electric Steel Foundry Co. P. O. Box 945, Houston 1, Texas (Electric Steel Foundry Co., 1920 Lorraine St., Houston 10, Texas).

ROLFS, E. L., Crutcher-Rolfs-Cummings, P. O. Box 2073, Houston 1, Texas (Crutcher-Rolfs-Cummings, 7825 Katy Rd., Houston 2, Texas).

SHEPARD, HARRY L., National Carbon Co., Inc., 3318 Nottingham Houston 5, Texas (National Carbon Co., Inc., 3318 Nottingham St., Houston 4, Texas).

UBBEN, JAMES E., Emsco Derrick & Equipment Co., Box 368, Garland, Texas (Emsco Derrick & Equipment Co., 7626 Denton Dr., Dallas, Texas).

WILBANKS, HUGH, JR. Gas Dept., City of Corpus Christi, Box 1622, Corpus Christi, Texas (Gas Dept., City of Corpus Christi, Box 111, Corpus Christi, Texas).

WIMER, CHARLTON J., Wimer Engineering Co., 711 Reserve Life Bldg., Dallas 1 Texas (711 Construction Bldg., Dallas Texas).

ZARUBA, RICHARD S., 1748 Richmond, Houston 6, Texas (4710 Clay, Houston 3, Texas).

UTAH

ERICKSON, BERT E., The Mountain States Tel. & Tel. Co., Box 959, Salt Lake City, Utah (70 South State St., Salt Lake City, Utah).

WASHINGTON

EVERHART, E. WAYNE Kaiser Aluminum & Chemical Corp., Trentwood Works, Box 1451, Spokane 6, Washington (The Permanente Metals Corp., Trentwood Works, Box 1451, Spokane 6, Washington).

WEST VIRGINIA

HAMSTEAD, A. C., Carbide & Carbon Chemicals, Div. of Union Carbide, South Charleston 3, West Virginia (Carbide & Carbon Chemicals Corp., South Charleston 3 West Virginia).

FOREIGN

BERNARD, KENNETH N., Naval Research Esth., 74 Victoria Rd., Dartmouth, Nova Scotia, Canada (Defense Research Board of Canada, Naval Research Esth., H.M.C.S. "Stadacona," Halifax, Nova Scotia).

GODARD, H. P., Aluminum Laboratories, Ltd., Box 84 Kingston, Ontaria, Canada (Aluminum Laboratories, Ltd., Attn. Librarian, Box 84, Kingston, Ontaria, Canada).

HOPKINS, ARTHUR JAMES, Hume Steel Ltd., P. O. Box 4534, Melbourne, C. 1, Vic, Australia).

JOPP, J. M., Chief Engineer Brown Corp., La Tuque, Quebec, Canada (Brown Corp., La Tuque, Quebes, Canada).

KELLAM, G. D., Canadian West Natural Gas, 215 6th Ave., W., Calgary, Alberta, Canada Canadian Natural Gas Light Heat & Power, 215 6th Ave., W., Calgary, Alberta, Canada).

ROGERS, R. R., Dept. Mines & Technical Surveys of Canada, Mines Branch, 568 Booth St., Ottawa, Canada (Dept. Mines & Resources of Canada, Bureau of Mines, 568 Booth St., Ottawa, Canada).

WATSON, T. R. B., Dominion Magnesium Limited, Suite 1505, 320 Bay St. Toronto, Ontario, Canada (Dominion Magnesium Limited, Suite 406, 67 Yonge St., Toronto, Ontario, Canada).

HADDAD, IBRAHIM SAMI, Trans Arabian Pipe Line Co., P. O. Box 1348, Beirut, Lebanon (Trans Arabian Pipe Line Co., Beirut, Lebanon).

MOYLE M. W., Cia Carbonifera de Sabinas, S. A., Rosita, Coahuila, Mexico (Cia Carbonifera de Sabinas, S. A., Rosita, Coahuila, Mexico).

NEW NACE CORPORATE MEMBERS

Added since last published list:

ARMCO STEEL CORPORATION
Middletown, Ohio

Arba H. Thomas,
Representative

Fast Steel Making

Details of a "Turbo-Hearth" method of steel making were revealed before the annual AIMME meeting at New York February 16 by C. E. Sims, assistant director of Batelle Memorial Institute, Columbus, Ohio and F. L. Toy, assistant to the manager Research and Development Division of Carnegie-Illinois Steel Corp., Pittsburgh, Pa. "Turbo-Hearth" steel is made without external fuel, impurities being burned away by a blast of air applied from the side at the surface of the charge. Average time of heat was 12 minutes. If oxygen is added to the blast this time can be speeded up. A 30-ton "Turbo-Hearth" is said to have a capacity equal to a 225-ton standard open hearth furnace.

Corrosion Mitigation Discussed at United Nations Meet*

Systematic Research Urged by Speakers as Means of Reducing Huge Economic Losses

By W. BECK*

UN Papers Referred to in This Article Published in CORROSION:

●

THE COST OF CORROSION TO THE UNITED STATES by H. H. Uhlig. Vol. 6, No. 1, 29-33 (1950) Jan.

●

PREVENTION OF CORROSION BY MEANS OTHER THAN PROTECTIVE COATINGS by F. L. LaQue. Vol. 6, No. 2, 72-78 (1950) Feb.

THE ATTENTION given corrosion at this conference of the United Nations is particularly appropriate. It represents an example of how the nations of the world can expedite progress by their united efforts in bringing to light the basic principles by which difficulties can be avoided.

A short review of the corrosion papers submitted to the United Nations Conference on September 1st will be given in this report.

A paper read by Dr. H. H. Uhlig' deals with the costs of corrosion to the United States.

Dr. W. H. G. Vernon considered in his paper the cost of corrosion and its control in relation to the world shortage of metals and the increasing demand upon the world's metal resources. The author referred to the fact that the aggregate economic loss due to corrosion is enormous because to the actual loss of metal must be added, to complete an economically vicious circle, the still greater amount of ores, fuel and fluxes, used up in its replacement.

World Iron Rust Cost Estimated

Sir Robert Hadfield estimated in 1922 that the annual world cost of steel and iron wasted by rusting was of the order of £600 millions. Dr. Hudson estimated recently the total costs of corrosion prevention of iron and steel for the United Kingdom alone as £200 millions annually. It is instructive to learn that the total annual cost met by a large British Industrial undertaking for painting maintenance is approximately £270,000. In a few cases the same organization obtained information on the cost of structural steel replacement due to atmospheric corrosion, which came to approximately £200,000 annually. In many other cases material loss is subordinated to the wastage of time and effort for which corrosion is responsible. A leaky condenser tube—caused by localized corrosion—may hold up a plant engaged in vital production or slow down a battleship. Here the effects are serious to an extent that is out of all proportion to the cost of replacement.

Dr. Vernon then covered the extensive field of structural engineering more in detail. Service life of about 60 years is expected from structural work, justifying relatively high initial cost of corrosion prevention. It is more economical to protect the steel parts by a coating than to overdesign its thickness. On the basis of the large area of structural steel exposed to the atmosphere it will be more economical to apply low alloy steel than stainless steel. It is economical to use more extensively low-alloy steels, corrosion resistance of which is of a lower order than that of stainless steel. These steels also afford improved adhesion to paint coatings to which their greater intrinsic resistance provides a second line of defense if and when the coating fails.

With regard to prevention of corrosion of structural steel work considerable emphasis is placed on good surface preparation which can lead to a material reduction of long-term total cost.

Use of Coatings Is Increasing

The periods between repainting can be extended very considerably by improving the method of surface treatment. Extending the interval of repainting from 3 to 5 and finally up to 7 years reduces the total cost for 50 years in the ratios of 53, 25, and 20 respectively. Dr. Verson mentioned further the so-called temporary protectives. The use of these substances is growing constantly. Preservation of machined iron and steel surfaces during storage or transport is a matter of considerable commercial importance, particularly in overseas trade. The author touched finally the protection of underground pipe lines against corrosive damage. This problem is of particular importance since a high proportion of the 80,000 miles of water mains buried in England and Wales are laid in clay soils known to be aggressive.

Like Dr. Uhlig, Dr. Vernon finally recommended the performance of more systematic research by a team of scientists and economists concerned with the production and use of metallic materials.

Dr. U. R. Evans discussed in his paper the role of protective coatings in the conservation of metals. After describing various methods of application of metallic layers, such as electroplating, dipping in molten metal, heating in powder, exposure to a vaporous compound or spraying, the author discussed more in detail cathodic and anodic coatings. Copper is strongly cathodic toward steel; lead and tin sometimes cathodic, sometimes anodic. In general a cathodic coating can prevent rusting only if it is impervious; pinholes must be avoided. It is usual to prescribe a minimum thickness since the risk of pinholes tends to diminish with increasing thickness. When a Zn or Al coating is applied to steel, discontinuities can under some circumstances be tolerated without risk of attack on the steel. The Zn or Al is the anode and suffers corrosion while steel being the cathode often receives protection. In other words, these metals retard the corrosion of steel by protecting the metal cathodically. In general coatings consisting of sprayed Al last longer than a Zn coating of the same

★ Scientific Conference on the Conservation and Utilization of Resources, August 17-September 6, 1949, Lake Success.

• Corrosion Research Laboratory, Department of Metallurgical Engineering, Lehigh University, Bethlehem, Pa.

PROTECTIVE COATINGS

BASED ON COPOLYMER VINYL RESINS

LINETITE

For specific heavy duty applications.

VINYL-CLAD

For general maintenance on exterior or interior surfaces.

VINYL-CLAD SYSTEM

Involves primer to seal off surfaces which cannot be prepared by conventional cleaning methods.

VINYL-CLAD Hi-Resist Black

Chemically inert and high abrasion qualities.

Descriptive literature and samples available on above products.

PLASTIC LINING CORPORATION

PROTECTIVE PLASTIC COATINGS

914 South Wabash Avenue **Chicago 5, Illinois**

World's Pioneer of Vinyl Industrial Protective Coatings

thickness. It is still more effective to apply a covering of paint on the sprayed Al surface. Presence of this metal between steel and paint also prevents darkening of the paint due to migration of ferrous salts through the coating and precipitation of iron oxide at the paint surface. It is advisable to apply a 3-stage procedure to the protection of metal surfaces:

1. Shot blasting
2. Spraying with Al or Zn
3. Application of an oil paint

Such a procedure has been found effective in protecting steel against corrosion under adverse conditions in many parts of the world during the last ten years. Coatings containing 25 percent of metallic Zn are very effective and may be obtained by the use of chlorinated rubber or polystyrene richly pigmented with Zn dust. Best protection by oil paints is achieved if the priming coating contains an inhibitive pigment, the outer coating being chosen to prevent mechanical or chemical deterioration of the primer.

Clean Surface Essential

Even a good painting system gives inferior results if not applied to a clean surface. Protection is least effective if the paint is applied at a stage when the greater part of the surface is still covered with mill scale. Most efficient methods of removing scale and rust are by pickling or grit blasting if large structures have to be cleaned. Wire brushing or flame cleaning do not remove scale and rust completely.

It is Dr. Evans' opinion that a paint is needed urgently which will confer good protection to a bad surface. More work is being devoted to the development of such a painting system, and the author believes that despite a number of disappointments success will be attained ultimately.

With regard to pre-treatment, good results can be obtained in many cases by applying a phosphate layer, especially if galvanized iron has to be painted. A very promising procedure consists of covering the steel surface with a very thin and continuous layer of tin before painting. The author emphasizes the desirability of collecting more comprehensive data characterizing the behavior of protective coatings if exposed to corrosive environments in outdoor tests. Results of accelerated tests performed in the laboratory must be interpreted very critically to avoid misleading conclusions. Finally, Dr. Evans suggested a closer collaboration between scientist and salesman and considers in a somewhat critical manner the value of discussions of actual corrosion problems at meetings of technical committees and associations.

In his paper submitted to the United Nations Mr. F. LaQue[2] considers thoroughly the prevention of corrosion by means other than protective coatings.

Pipe Protection Described

In another paper Dr. J. E. Carriere and Dr. C. A. Lobry de Bruyn discuss the cost and benefits of conservation of cast iron and steel pipe lines by control of corrosion. The authors describe the nature of the soil in the Netherlands and the corrosion performances of the cast iron and steel pipes located in the various soils of this country. In general

ACIPCO PIPE
Resists
CORROSION

Mono-Cast Centrifugal Cast Iron Pipe
High resistance to Soil Corrosion

Used extensively for:
- WATER LINES
- GAS LINES
- SEWER LINES
- OIL LINES
- FOAMITE LINES, ETC.

Mono-Cast Alloy Iron
- CONDENSER COILS
- SPECIAL SERVICE

Centrifugally Cast Steel Tubes
- PLAIN CARBON
- HIGH ALLOY, including
- 18/8 & 25/20 CHROME-NICKEL

American
CAST IRON PIPE
Company
BIRMINGHAM 2, ALABAMA

PAINTING MAINTENANCE FOR INDUSTRY

Specializing in the Utility and Industrial Fields

SERVING THE NORTHEAST REGION

Devoted to the proper preparation of surfaces and the application of anti-corrosive material.

Inquiries Invited

WILLIAM G. PITTMAN
210 MAIN STREET, HACKENSACK, N. J.
HAckensack 3-5185

N.A.C.E. Member

the soil is very aggressive and the problem of pipe protection is of a predominant importance for the Netherlands. The procedures being applied to the pipes to active effective corrosion preservation are discussed, and a description is given of the specifications for pipe coatings and the methods used for testing soil aggressivity in Holland. A final section deals with the savings on costs being accomplished by protecting the pipes with bituminous coatings of a high durability.

The paper submitted by Prof. G. Chaudron represents a short review with respect to the conservation of metals by corrosion control covering the practical importance of the corrosion rate of a metal, the improvement of the corrosion resistance by the addition of alloying elements to metals with low corrosion resistance, and the specific influence of the corrosion process on the mechanical characteristics of a metal. The author describes further the nature of various corrosive environments and the value and the economy of a protective coating. Prof. Chaudron emphasizes the fact that in many metals the susceptibility to corrosion can be improved by very great purification, 99.9 Al, for instance, has exceptional corrosion resistance in comparison with 99.5 Al, and alloys made from very pure Al have similar properties.

Dr. M. Pourbaix[3] spoke about the International Committee of Electro-chemical Thermodynamics and Kinetics organized recently to facilitate and promote international cooperation in investigating electrochemical thermodynamics and kinetics. The chairman of this committee is Prof. P. VanRysselberghe of the University of Oregon.

The author of this article (Dr. Beck) described briefly the activities of another international organization with which he worked until the outbreak of war. It is the International Joint Commission (Commission Mixte Internationale C. M. J.) established 20 years ago by the International Advisory Committee for Telecommunication, the International Railway Association and the International Committee for studying problems concerned with the operation of long distance high voltage transmission lines. It is a goal of this commission to study the efficiency of protective procedures applied to underground pipe and cable lines. The governments of many countries are represented in the C. M. J. by delegating officials of various departments interested in corrosion to its assemblies. Numerous technical associations and telephone companies are represented in the commission too.*

Tremendous Savings Possible

The papers submitted to this important meeting of the United Nations made again evident what a tremendous amount of money can be saved by protecting effectively metallic structures against corrosive deterioration. However, it must be borne in mind, as stated in Dr. Uhlig's paper, that the savings are not alone in dollars and cents. There are direct and indirect savings of metals, coal, oil, water, and other of our exhaustible material resources and not least there is a substantial saving of human effort. Increasingly successful effort to combat corrosion represents social and material gain for mankind.

* A review of the corrosion topics discussed at the last annual meeting of the C. M. J. in Paris is being prepared for publication in CORROSION.

References

1. H. H. Uhlig, The Cost of Corrosion to the United States. *Chem. & Eng. News*, **27**, 2764 (1949). *Corrosion*, **6**, 29-33 (1950) Jan.
2. F. L. LaQue, Prevention of Corrosion by Means Other Than Protective Coatings. *Canadian Metals and Metallurgical Ind.*, **12**, No. 8, 14 (1949) Aug. *Corrosion*, **6**, No. 2, 72-78 (1950) Feb.
3. M. Pourbaix, University of Brussels, Belgium.

Canadian Meeting Set

The fourth annual Eastern Regional Conference of the protective coatings group of the Chemical Institute of Canada was scheduled March 17 at Montreal, Que. The institute is a member of the Inter-Society Corrosion Committee.

Scheduled items of apparent corrosion interest included: The Use of Styrene in Protective Coatings, by W. E. K. Middleton; How Pigments Work, by C. E. Barnett.

CORROSION DIRECTORY

Rates for notices under this heading can be obtained from National Association of Corrosion Engineers, 919 Milam Building, Houston 2, Texas

South Florida Test Service
INSPECTION – TESTING – RESEARCH ENGINEERS
(Established 1931)
Corrosion, weathering and sunlight tests. Four locations in Southern Florida for inland, salt atmospheric, tidewater and total immersion exposure tests.
4201 N. W. 7th St. MIAMI, FLORIDA

STATIONARY COATING & WRAPPING
COMPLETE PIPE RECONDITIONING
Plants – Corpus Christi – Refugio, Texas
Jackson, Miss.
ROSSON-RICHARDS CO.
Box 908–Corpus Christi–Ph 3-5121 & 2-9021
Portable Units Available for Rail-Head Coating Anywhere

CORROSION SURVEYS
Recommendations and supervision of corrosion control methods and protective coating and lining installations.
KENNETH TATOR
ASSOCIATES
Montour St. Ext. Coraopolis, Pa.

SERVING ALL PIPELINES
PIPELINE ASBESTOS FELT
Made by The Ruberoid Co.
COAL TAR ENAMEL COATINGS
Made by Pittsburgh Coke & Chem. Co.
"Steve" Day
S. D. DAY COMPANY
2017 W. Gray Houston 19, Tex.
Phone KE-0407

RESEARCH PRODUCTS FOR SOLVING PROTECTIVE COATING PROBLEMS
Product Development — Application Engineering
SPECIALTY COATINGS LABORATORY
1721 North Water Street
MILWAUKEE 2, WISCONSIN

A. R. FOX
Corrosion Engineering Service
Cathodic Protection - Non-Destructive Testing
Special Investigations
Miscellaneous Instruments & Supplies
3405 Piedmont Ave.
Oakland 11, Calif.

STARR THAYER
Consulting Engineer
Corrosion mitigation on existing structures; protection designed for new structures.
614 S. Standard Bldg. Houston, Texas

• **SALES** • **ENGINEERING**
• **INSTALLATION**
Federated Magnesium Anodes – Cadwell Welding Supplies
F. H. Maloney Insulating Materials
Complete line of Cathodic Protection Equipment
PIPELINE MAINTENANCE CORP.
811 So. Boulder Phone 3-0846
TULSA, OKLAHOMA

Complete
CATHODIC PROTECTION
Systems . . . supplies . . . service for special applications; water tanks and pipe lines.
HARCO CORPORATION
2154 East 4th St. Cleveland 15, Ohio

Cathodic Protective Systems Designed and Installed
Coating and Laying Specifications;
Corrosion Surveys; Consultation On
All Types of External Pipe Line Corrosion.
Huddleston Engineering Co.
Bartlesville Oklahoma

CATHODIC PROTECTION
Surveys — Engineering
Installation — Maintenance
Electro Rust-Proofing Corp. (N. J.)
BELLEVILLE 9, NEW JERSEY
Atlanta – Chicago – Dallas – Monrovia

NEW PRODUCTS – Materials – Service – Literature

Pore Sealing of metal castings by a batch immersion process unit is explained in a brochure available from Western Sealant, Inc., 9042 Culver Boulevard, Culver City, Calif.

•

Examples of Metallizing of metals under various conditions and histories of successful applications for periods up to 25 years are given in *Metco News*, a publication of Metallizing Engineering Co., Inc., 38-12 Thirtieth St., Long Island City 1, New York. Copies are available on request.

•

Enameling Burning, pickling equipment, high temperature equipment and chain are described and illustrated in an 8-page brochure available from Strohecker, Inc., Enon Valley, Pa. Fabricated of Inconel, Monel and other high-alloy materials the equipment is designed for highly corrosive environments. Advantages claimed are longer life and increased efficiency by reduced weight of components.

•

Shot Cleaning without the use of compressed air or water is possible with the equipment designed by American Wheelabrator & Equipment Corp., Mishawaka, Indiana. The "Wheelabrator" is a rapidly revolving wheel divided into compartments radially. Shot is fed into the wheel near the axis and the radial elements impart velocity to them before they are emitted at the wheel's circumference. The equipment is used for many types of production work where shot cleaning is desirable.

•

Counter-rotating shafts, propeller equipped, produce an annular rather than circular flow up to 48,000 cuts per minute in the new counter-rotating mixer developed by Brookfield Engineering Laboratories, Inc., Porter Street, Stoughton, Mass. Folder on this laboratory mixer is available on request.

•

Containers for chemical, pharmaceutical, petroleum, food and brewing, and other industries, welding, repair, erection and metallizing services are shown in a brochure issued by Nooter Corp., St. Louis, Mo., available on request. The firm fabricates many types of vessels of corrosion-resistant pure, alloyed and clad metals. Extensive tables rating corrosive substances against 16 metals and alloys are included.

•

Cleaning and Treating metal surfaces in one operation is effected by the Oakite CrysCoat Process explained in detail in the January-February issue of *Oakite News Service,* a periodical issued by Oakite Products, Inc., 22 Thames St., New York 6, N. Y. The process involves three stages, application of CrysCote, water rinse, dilute chromic acid rinse. The process can be used in a standard, ordinary steel, three stage metal washing machine. There is no need to provide acid proof parts or to replace corroded parts, the booklet states. The film imparted by the treatment weighs 60 to 90 milligrams per square foot of surface, claimed to be ideal for application of minimal thicknesses of paint.

Oakite Compound No. 33, also reported in the issue, is said to remove grease, rust, oxides, soldering flux, heat scale, smut and similar formations with hand application or drip tank methods, without heat. It also conditions ferrous and aluminum surfaces and phospatizes surfaces, all in one operation.

•

Glass Fiber reinforcement for coatings protecting underground pipe lines against corrosion is explained in a brochure issued by Oklahoma Glass Fiber Corp., Newport, Ark. The folder illustrates the fundamental theory of electrolytic corrosion of steel, lists common methods of protection and gives results of a test of OK Glass Fiber Reinforcing by United States Testing Company. Middle West Coating & Supply, 807 Daniel Building, Tulsa, Okla., is distributor of the material.

•

Tube Turns, Inc., Tulsa office has been moved to, 420 Wright Building.

•

Chlorinated Rubber base paint named "Silon" is manufactured by Silon, Inc., P. O. Box 317, Wooster, Ohio. Results of a competitive test with 15 other protective coatings by one of the three largest rubber manufacturing firms in the world show Silon to be best, the manufacturers state.

Testing was done on 20 duplicate metal test panels submerged halfway in test solutions containing 1 milliliter per panel, sulfuric acid 15%, 250; nitric acid 15%, 250; hydrchloric acid conc., 250; saturated caustic soda solution, 125. Panels were tested in salt spray equipment with saturated sodium chloride solution and outdoor test panels were mounted facing south at 45 degrees. Outdoor panels were exposed to spray from cooling water nozzles. Length of tests varied from 5 to 74 days in acids and caustics. Kerosen test was 73 days; salt spray test 44 days; outdoor test, 66 days. The technical data sheet lists details of the testing program and gives ratings of the 16 paints in five categories.

•

Corrosion-resistant flooring comprised of various kinds of asphalt mastic and acid-proof brick are described in literature available from Ralph V. Rulon, Inc., 3900 N. Second St., Philadelphia 40, Pa.

•

Multi-Stage Boiler Feed and high pressure service centrifugal pumps, adaptable to electric motor, turbine or engine drive are explained and diagrammed in a brochure issued by American-Marsh Pumps, Inc., Battle Creek, Mich.

•

For Metal in Underwater Service, Dampney Metal Primer, a vinyl butyral resin formulation serves temporarily as a corrosion inhibitor, improves bonding and increases corrosion resistance of the material applied over it the manufacturers claim. Applied by brush or spray in ¼ to ½-mil thicknesses, it dries in half an hour. A specification sheet and other descriptive information may be obtained from The Dampney Co. of America, Hyde Park, Boston 36, Mass.

•

Six Aluminum paints for six kinds of service are given in a folder issued by the Skybrite Company, 3125 Perkins Ave., Cleveland 14, Ohio. General characteristics of the paints are given.

•

Water Hardness tests involving direct titration with a distinct color change at end point have been developed by Hall Laboratories, Inc., Pittsburgh, Pa., substitutes for the time-honored "soap shaking" method. Total hardness and calcium hardness alone can be differentiated. Interferences are easily eliminated, the laboratory claims. The Hagan calcium test also is a direct titration to a clear-cut color change. The answer, correct to 1 ppm calcium is found in one minute. All equipment and reagents required for either test are available from Hagan Corporation, Calgon, Inc., and The Buromin Company.

•

High Pressure cartridge type relief valve for presure settings from 100 to 5000 psi has been developed by Pantex Manufacturing Co., Pawtucket, Rhode Island. The valve opens and closes within a 7 percent differential, it is silent, eliminates wire draw and provides high volume flow at all pressures and has been tested through temperature variations from —65 degrees to +160 degrees F with maximum of 5 percent change in operating characteristics, the company says. Data sheets and descriptive literature are available on request.

•

R. E. Mundy Co., 1520 Cleveland, S.W., Roanoke, Va., has been named sales representative in Central Virginia and adjacent West Virginia territory by the Dampney Co. of America, Hyde Park, Boston, Mass.

•

Scale and Corrosion on pipe are removed by 84,000 blows per minute of approximately 1½-lb. striking power per blow, and air exhaust from the hammers is directed to blow away the loosened corrosion products in the Throcker Corrosion Master, distributed by the Engineering Development Co., 1742 Quentin Ave., Lansing, Mich. Requiring only six inches of clearance around the pipe, which does not have to be raised above ground, the four and six-inch machines weigh 62 lb. and the 10 to 24-inch machines 90 lb. Operation by one man is claimed, with a cleaning capacity of 300 to 600 feet of pipe per day. Air demand for 4, 6 and 8-inch machines is approximately 60 cu. ft. at 80 lb. and for 10 to 24-inch machines, 90 cu. ft. at 80 lb.

•

Anti-Corrosive paint "Subox" and "Subalox" manufactured by Subox, Inc., Hackensack, N. J., will be handled by the following sales representatives: John S. Hart & Sons, 80 E. Jackson Blvd., Chicago 4, Ill.; Williamson Sales Co., Box 1223, Shreveport, La.; Freeman W. Kennedy, 124 S.W. First Ave., Delray Beach, Fla.; A. A. Barbera & Co., 113 N. Martel Ave., Los Angeles, 36, Cal.

Permanent pressure around pipe, which tends to exclude moisture, is claimed for Polyken corrosion protection tape by Bauer & Black's Industrial Tape Department. The oriented polyethylene film, adhesive coated on one side, has greater elasticity and strength than melt-extruded forms of polyethylene, the company says. Soil-box tests showed the tape, when a 2-inch width was wrapped around standard 2-inch steel pipe with ¾-inch overlap, buried in Bentonite clay and alternately wet and dried over eight months at 63 degrees C, had a resistance of 3 megohms per square foot tested with 1 to 5 volts DC. The equivalent of over three years weathering (Weather-O-Meter) resulted in no significant change in the properties of the material. Properties listed include: Insulation resistance (ASTM D-257-46 modified), 10^6 megohms. Dielectric strength (ASTM D-149-44 at 500 v/sec. voltage rise) 10,000 v (rms), 1400 v/mil avg. Moisture absorption (at 30 degrees C and 100 percent RH), 0.1 percent. Moisture vapor transmission (at 30 degrees C and 100 percent RH), 0.2 g/100 sq.in/24 hr. Temperature range (operating) good dimensional stability, (—40 degrees C to 100 degrees C) Underground aging and soil bacteria tests showed it does not support growth of soil bacteria. Strength and elongation (ASTM D-39-39 grab) 1-inch wide sample, 20 lb., ASTM method 38-40 lb. Wrapping tension recommendations (finishing turn zero tension) 5 lb./sq. in. Plastic Engineering & Sales Corp. (PESCO) P. O. Box 1037, Fort Worth, Texas, distributor will furnish further details and samples on request.

•

Stainless Steel valve clinic, second in a series of such clinics sponsored by the Cooper Alloy Foundry Co., Hillside 5, N. J. will be held April 26 in the form of a dinner meeting at Statler Hotel, Buffalo. Attendance is by invitation only, tickets being available free on a first come-first served basis from the company's New Jersey office. No sales representatives of the foundry's distributor chain will be invited.

•

Resin and Catalyst-Bearing carbon powder, mixed to a stiff putty and applied by trowel to dried and cleaned wood and metal surfaces will protect them against action of corrosives to about the same extent as carbon and most acids except nitric and chromic and most solvents except ethylene dichloride and most alkalis are said not to attack Carboline, a product of the Carboline Co., 7603 Fortsythe Blvd., St. Louis 5, Mo. The material dries to a permanent bond on wood. Good adhesion to steel is obtained with a primer. Coats up to 1/16th inch can be made on vertical surfaces without sagging, and greater thicknesses are possible by adding coats. On all metal surfaces glass cloth is laid between two coats of lining material. The lining sets readily at room temperature of 70 degrees F and dries usually in 24 hours. Heat resistance on unprimed surfaces is good to 350 degrees F. Solvent content of mixed material is less than 10 percent. Bulletins C-6a and C-7 describing the material, are available on request.

•

Diaphragm Valves, lined with corrosion resistant materials, with a body material of almost anything castable and linable are listed in Bulletin V-50A by Hills-McCanna Company, 3025 N. Western Ave., Chicago 18, Ill. Details of the Saunders Patent valve are given together with a list of sizes, styles and materials in which cast and kinds of lining. Thirteen kinds of linings are offered by the company.

•

Vinyl Plastic coatings, ready-mixed under the trade name "Calvinac" are being made by James Lithgow Co., Inc., Los Angeles 22, Cal. A bulletin listing applications is available on request.

•

Flashlight Batteries in which the container is made of carbon, with a zinc power vane as the center element immersed in the electrolyte are being made by National Carbon Division, Union Carbide and Carbon Corp., 30 E. 42nd St., New York 17, N. Y. The company claims the new 1050 cell gives more light-minutes than previous cells, and will not corrode or stick in the container because the case of the cell is inert.

PERSONALS

Erskine W. Manterfield has been appointed director of publications and advertising for American Locomotive Company, Schenectady 5, N. Y.

•

J. M. Spangler, formerly director, vice-president and general manager of National Carbon Division, Union Carbide and Carbon Corp., has been named president of the division after 35 years of service.

•

John E. Lothian has been appointed a business consultant of Ebasco Services Incorporated. He previously was associated with Industrial Commodity Corporation.

•

Dr. William G. Theisinger has been named regional manager by Lukens Steel Company with headquarters in Houston, Texas. He has been manager of technical sales with headquarters in Coatesville, Pa., for four years.

•

Donald H. Jones has been appointed general sales manager for the coating and Fibron divisions of Irvington Varnish & Insulator Co., Irvington, N. J.

•

David Kirk Stuart has been appointed manager of the Pittsburgh branch of Crucible Steel Co. of America, and **Richard J. Rand** has been named assistant branch manager.

•

Curtner B. Akin has been named manager of the mechanical tubing department of National Electric Products Corp., Pittsburgh.

•

Dr. Horace W. Gillette, 66, chief technical advisor for Batelle Memorial Institute, formerly director of the institute and credited with organizing the institute's technical activities, died March 3 near Nicholasville, Ky. from a heart attack when returning from a hunting trip. He was an internationally - known authority on metallurgy.

•

Thomas P. Gallagher has been named assistant salesmanager of Munray Products Co., Inc., 12400 Crossburn Ave., Cleveland, Ohio.

Synthetic methyl esters of long chain oxygenated hydrocarbons derived from partially oxidized petroleum fractions by the Alox process.

EFFECTIVE CONTROL of Corrosion in:

- **Sheet Steel**
- **Internal Combustion Engines**
- **Hydraulic Systems**
- **Turbine Systems**
- **Fabricated steel parts during processing, storage or shipping**

As little as 1% of ALOX 350 additive is found to be effective in producing the metal wetting and anti-corrosion characteristics desired.

RESEARCH DATA AVAILABLE TO YOU

Write . . . directly attention SALES DEPT.

ALOX CORPORATION
3953 BUFFALO AVENUE
NIAGARA FALLS, NEW YORK

Corrosion Abstracts

Index to

CORROSION ABSTRACTS

1. GENERAL — Page
   1. Miscellaneous ... 24
   2. Importance ... 24
   3. Reviews ... 24
   4. Books ... 24
   8. Fundamentals ... 26

2. TESTING
   1. General ... 28
   2. On Location Tests ... 28
   3. Laboratory Methods ... 30

3. CORROSION TYPES & INFLUENCING FACTORS
   1. General ... 32
   2. Types ... 32
   3. Factors Biological ... 32
   5. Physical and Mechanical ... 32
   7. Factors Metallurgical ... 34

4. CORROSIVE ENVIRONMENTS
   1. General ... 34
   2. Atmospheric ... 34
   3. Chemicals Inorganic ... 34
   4. Chemicals Organic ... 36
   6. Water ... 36

5. PREVENTIVE MEASURES
   2. Cathodic Protection ... 40
   3. Metallic Coatings ... 42
   6. Packaging ... 42
   8. Inhibitors ... 42
   9. Surface Treatment ... 43

6. MATERIALS OF CONSTRUCTION
   1. Ferrous Metals ... 44
   2. Non-Ferrous Metals ... 45
   3. Non-Metallic ... 46

7. EQUIPMENT
   1. Engines ... 46
   2. Valves and Pipes ... 47
   5. Containers ... 47

GENERAL

• Miscellaneous

1.1, 5.8, 2.2, 3.7

Symposium of the Corrosion Committee of the German Metallurgical Society Held in Clausthal on 30 May, 1948. *Metalloberflache,* **2,** No. 11, 247-248 (1948).

Hellmut Fischer spoke on the protective action of corrosion inhibitors and their evaluation, and considered: 1) the over-voltage and resistance theories, and 2) the relationship between short-time tests and practice. K. Lohberg dealt with the corrosion of intermetallic compounds, with special reference to results obtained from atmospheric and humidity chamber tests on Mg_2Pb, Mg_2Sn, AlSb, Mg_3Bi_2, Mg_3Sb_2, compounds of lead with antimony, bismuth, and tin, Mg_2Cu, $MgCu_2$, Al_2Cu, and AlCu. W. Wiederholt described the reclamation of scrap metals, the particular method employed depending on the surface condition of the material, i.e., whether the surface is rusty, burnt, or covered with oil and grease.—MA.

• Importance

1.2, 4.1, 6.1, 5.4

Cost and Benefits of Conservation of Cast Iron and Steel Pipelines by Control of Corrosion. J. E. Carriere. Paper before United Nations Scientific Conf. on Conservation and Utilization of Resources, New York, 1949. United Nations, Economic and Social Council, June 16, 1949. 10 pp.

Discussion includes soil conditions in the Netherlands, present conditions and near future requirements of cast iron and steel pipes, specifications for pipe coatings, testing of soil with regard to corrosiveness, and economic aspects.—INCO.

1.2, 1.3

Costs of Corrosion to the United States. H. H. Uhlig, Mass. Inst. of Tech. Paper before United Nations Scientific Conf. on Conservation and Utilization of Resources, New York, 1949. United Nations Economic and Social Council, May 6, 1949. 16 pp. *Chem. & Eng. News,* **27,** No. 39, 2764-2767 (1949) Sept. 26. *Corrosion,* **6,** 29-33 (1950) Jan.

Losses through corrosion include losses through over-design as well as loss of product, shut down, reduced efficiency, explosion and contamination. Reasonable planning and effort with regard to corrosion control can give substantial gains in conservation of metals and other resources. These gains come through increased attention to cathodic protection of submerged and buried structures, reduced corrosive wear of internal combustion engines, increased use of inhibitors and water conditioning, improved protective coatings and expanded application of corrosion resistant metals.—INCO.

1.2, 1.3

The Costs of Corrosion and of Its Control. W. H. J. Vernon. Paper before United Nations Scientific Conf. on Conservation and Utilization of Resources, New York, 1949. United Nations Economic and Social Council, June 30, 1949, 12 pp. *Sheet Metals Inds.,* **26**, No. 270, 2135 (1949) Oct. (Abstract).

Older estimates of annual loss of steel and iron by corrosion are reviewed in light of available present knowledge. Large scale reduction in corrosivity of main environments to which metals are exposed can be looked for only in atmospheric corrosion. Wider and more enlightened application of preventive measures is urged. Improved methods of corrosion control should lead to the greater conservation both of metal and of time and effort.—INCO.

• Reviews

1.3, 1.7

Corrosion Research in the Navy. J. J. Harwood & F. Schulman, Navy Dept. *Corrosion,* **5,** No. 7, 203-217 (1949) July.

Description of Office of Naval Research corrosion research program and its objectives and review of progress to date. Discussion includes description of corrosion types, and methods of control. Projects and problems are grouped: passivity and film formation, inhibitor and passivator, galvanic corrosion, general corrosion and high temperature oxidation. 18 references.—INCO.

1.3, 5.3, 5.4

Present Methods of Producing Protective Coatings on Light-Metal Alloys. E. Nachtigall. *Arch. Metallkunde,* 2, No. 6, 194-197 (1948).

An illustrated review of well known chemical, electrolytic oxidation, electrodeposition, and lacquering processes for the production of protective coatings on cast, die-cast, and wrought aluminum and magnesium alloys.—MA.

• Books

1.6, 1.8, 3.2

Hydrogen in Metals. By Donald P. Smith. Med. 8vo. Pp. xiii 367, illustrated. 1948. Chicago, Ill.; University of Chicago Press, 5750 Ellis Avenue. ($10.00.)

This book is the second to appear in the monograph series which is being published under the joint auspices of the Institute for the Study of Metals and the University of Chicago Press. The object of this series is, as the responsible committee says in its foreword, to promote "cross-fertilization" between various fields of research, and the subject of the present volume "Hy-

drogen in Metals" is of very considerable interest to both theoretical and practical metallurgists. It deals with the occlusion of hydrogen by metals by direct absorption from the gas phase, by pickling and by electrolytic action, the rates of such processes and the reverse one of evolution, and the effects produced by the presence of the occluded gas in the metal.

It may be said at once that this book should prove to be of very great assistance to those actively engaged in this field; the author has covered the subject with remarkable completeness, and the annotated bibliography, which contains some 1470 references, will undoubtedly be extremely useful. There are three main sections in the book: fourteen chapters discussing the general experimental evidence (244 pp.), some detailed supplementary notes dealing with various aspects only briefly mentioned in the main text (47 pp. of small type), and finally the general bibliography (68 pp.). Chapters I-V are short introductory ones describing the general characteristics of occlusion by metals, such as the variation in behavior with periodic classification, the rate of occlusion and the dimensional and mechanical changes produced by the uptake of gas. Chapter VI is a fairly long one on the occlusion of hydrogen by the metals in which the process is endothermic, i.e., iron, cobalt, nickel, chromium, copper, platinum, and silver. The next three chapters (VII-IX) are concerned mainly with the phenomena in the somewhat complex palladium system, and Chapter X with the other exothermic occluders, such as titanium, zirconium, and thorium. The anomalous elements, e.g., manganese, and the non-occluding metals are dealt with in Chapter XI, and the binary alloy-hydrogen system in Chapter XII. In Chapter XIII the author discusses the somewhat sparse evidence at present available on the effect of hydrogen on the magnetic properties of metals and alloys and its relation to constitution. The final chapter is devoted to a summary of the experimental evidence, and the author's general conclusions.

The reviewer has so far, in deference to Dr. Smith, written "occlusion" to describe the absorption of hydrogen by metals even in cases where he would have more naturally written "solution." Now this is a point on which Dr. Smith obviously feels very strongly; he considers that lattice defects or "rifts" in metals play a very large part in determining the behavior of a given metal-hydrogen system—that the hydrogen is frequently located in the metal mainly at these faults in the crystal lattice, and that various phenomena of absorption and desorption can be best explained in terms of the opening or closing of the faults by mechanical or chemical processes. In fact, he goes so far as to say (p. 3) that "it is at present open to question as to whether solid solutions occur at all in endothermic metal-hydrogen systems," and throughout the whole book his theoretical discussion of the experimental data tends to be dominated by the rift hypothesis. Indeed, it is not unfair to say that in a good many instances the author has strained the facts very severely in an attempt to make them conform to this theory, when a simple explanation based on lattice solution and diffusion would appear to be perfectly adequate. To give but one example, the results obtained by Euringer

Any of these "Proven Operators"

- ✓ Westinghouse, Bendix Westinghouse
- ✓ Barber-Colman, Cutler-Hammer and Philadelphia Limitorque motors
- ✓ All pneumatic motors
- ✓ Air loaded pneumatic motors
- ✓ All double and single action air cylinders
- ✓ Mechanical springs

may be used with HILLS-McCANNA Diaphragm Valves for automatic or remote operation

The extreme flexibility of Hills-McCanna diaphragm valves makes it possible to satisfy virtually any preference or requirement in the use of mechanical operators. All of the operators listed above plus others are applied to standard Hills-McCanna sliding stem valves to provide complete units that utilize your existing operating methods.

Designed especially for conveying "hard-to-handle" fluids such as acids, alkalis, volatile and viscous substances, slurries, semi-solids, etc. Hills-McCanna diaphragm valves give you the advantages of "special" design on a standardized basis. Sizes range from ⅜" through 14" (not all methods of operation are available in all sizes); pressure up to 150 psi; temperatures to 180°F. (some applications to 220°F.). Write for complete information, HILLS-McCANNA CO., 2460 W. Nelson Ave., Chicago 18, Ill.

HILLS-McCANNA

Saunders patent diaphragm valves

Proportioning Pumps

Force-Feed Lubricators • Magnesium Alloy Castings

Abstract Section Style Outlined

For ease in locating reference data, CORROSION uses a uniform style in its Abstract Section.

The abstracts first are broken down into major classifications of the more common types of corrosion literature. In each review the title of the article is presented in bold face type, followed by the author's name. The publication from which the article was abstracted is printed in italics and is abbreviated in most instances. Following this, in sequence, are the volume (bold face), number in the volume, pages, year and month of publication. In some instances a second reference will be listed in the same manner. This indicates that the article also was published or abstracted in another publication. A brief summary of the article follows the above information and it is concluded with an abbreviation indicating the source of the abstract and contributor. The meanings of these abbreviations usually are listed on the first page of the Abstract Section.

When seeking more detailed data about an abstract, best source of information is the publication in which the article appeared originally. (Listed in italics in the heading.) The contributor of the abstract also may be able to supply additional information. Addresses of most of these publications may be found in the reference section of most public libraries.

on the rate of evolution of hydrogen from nickel wires are quoted (p. 68) as evidence that the hydrogen is not contained in the metal in solid solution; actually Euringer's curves conform ideally to classical diffusion theory, and the argument put forward by Dr. Smith here is quite untenable. Many similar examples could be quoted. It would be idle to suggest, of course, that the segregation of hydrogen into lattice defects does not take place in any of these metal-hydrogen systems; in the case of iron, for example, especially when the metal is supercharged by electrolysis, the evidence is clearly in favor of some such mechanism. Dr. Smith, however, attempts to generalize too sweepingly in this matter, and in the reviewer's opinion, rather detracts from the value of his book in so doing. While in this vein, it may perhaps also be noted that on the whole, diffusion phenomena are not treated very adequately.

After these somewhat ungrateful remarks, it should be reiterated that Dr. Smith has performed a most valuable service in compiling this very exhaustive survey of a difficult field. The book is well produced, typographical errors are almost non-existent, and it is provided with an excellent index. It should certainly prove, to quote once again from the committee's foreword, an excellent basis and stimulant for further work.—C. E. RANLEY.—MA.

• Fundamentals

1.8, 3.6, 1.3

Recent Developments in the Study of Hydrogen Overpotential. J. O'M. Bockris. *Chem. Rev.*, **43**, No. 3, 525-577 (1948).

A comprehensive critical review of the present position of hydrogen - overpotential studies is presented. Slow discharge is not the general mechanism of hydrogen overpotential on various metals, the most important evidence supporting this conclusion arising from a) pH effects on metals of low overpotential, b) the transfer of overpotential through metallic films, and c) experiments on the individual velocities of various reactions at the cathode; on metals of low overpotential some form of slow-combination mechanism seems probable. It is unlikely that one mechanism of hydrogen overpotential is effective for all metals. More than 160 literature references are appended.—MA.

1.8, 3.4, 3.5

Kinetic and Structural Factors Involved in Oxidation of Metals. E. A. Gulbransen, Westinghouse Res. Labs. Paper, A.C.S. 113th Meet., Chicago (4/19-23/48); *Ind. Eng. Chem.*, **41**, 1385-91 (1949) July.

Studies are reported of the rate of formation and structural characteristics of the thin oxide film associated with protection of metals against high temperature oxidation and corrosion reactions. Oxidation curves for molybdenum, tungsten, iron, aluminum and magnesium are presented and the effect on these of temperature, pressure and surface area discussed. (23 references.)

1.8, 3.5, 3.4

Oxide Films Formed on Metals and Binary Alloys. An Electron Diffraction Study. J. W. Hickman, Westinghouse Electric Corp., Research Laboratories, East Pittsburgh, Pa. AIMME, New York, N. Y., Technical Publication No. 2483. 18 p. (1948) Dec.

An extensive study of the oxide films formed on metals and binary alloys at various temperatures led to the following conclusions:

Oxide Structures on Metal Surfaces

The oxide structures of thin films are identical with those of bulk oxides as determined by X-ray diffraction. Oxidized iron shows three structural transitions: At 225° C gamma Fe_2O_3 transforms to alpha Fe_2O_3; at 225-450° C the latter changes to Fe_3O_4; this in turn transforms to FeO at 450-550° C. The last transition is thermally reversible. Oxidized cobalt exhibits only one structural change from Co_2O_4 to CoO at 400-600° C.

In the temperature ranges studied no lattice transitions were found for the oxides formed on nickel, chromium, copper, beryllium, uranium, thorium, titanium, and zirconium. The absence of CuO on copper is due to the fact that the camera must be evacuated before a photograph is taken; this results in the decomposition of CuO to Cu_2O, since the partial pressure of oxygen in the camera is lower than the oxygen pressure over CuO at 600° C. The occurrence of rutile TiO_2 on titanium in the low-temperature range where the anatase modification TiO_2 is expected may be compared with the occurrence of FeO in the form of thin films on iron at temperatures lower than those observed when bulk samples are investigated.

On tungsten and molybdenum irreversible structural transitions occur from the trioxide to the dioxide with an elevation in temperature. The transition temperature for tungsten apparently depends on the thickness of the oxide film, but for molybdenum the results are inconclusive in this respect.

The diffuse diffraction patterns observed with oxidized zirconium, and the difficult removal of this oxide film from the substrate, may be evidence of solubility of the oxide in the metal.

Oxide Structures on Binary Alloy Surfaces

It is generally impossible to predict the oxide that will be observed from the thermodynamic stabilities of the several possible oxides or from the sizes of the ions that may form. Oxides of some of the elements, such as silicon and zirconium, are not found in the outer surface of the oxide layer. Within the time studied some alloys show the presence of oxides of only one of the metals, indicating that ions of the other metal have lower rates of formation and diffusion at the temperature studied. On

Federated first for Magnesium Anodes

Only Federated gives you magnesium anodes with:

Integrated Core . . . an electro-galvanized, full-length, spiral-wound strip core perfectly bonded to the magnesium alloy . . . assures continuing operation.

Silver-Soldered Lead Wire Connections for lasting, non-corrosive connections with low resistance.

Shape and Weight To Your Specifications . . . for maximum efficiency. Stock sizes also: 5" sq., 4" sq., and 3" sq., in lengths from 15" to 66".

Federated also supplies PACKAGED ANODES of standard 17 lb. and 32 lb. size with backfill to your specification . . . for easy field installation.

Federated Metals Division

AMERICAN SMELTING AND REFINING COMPANY • 120 Broadway, New York 5, N.Y.

Federated first in the non-ferrous field FMD

other alloys, oxides of one of the metals form at low and of the other metal at elevated temperatures, indicating that the rates of formation and diffusion of the two metallic ions vary in a different manner with the temperature.

Heating and cooling experiments show that solid-phase reactions occur when oxides on the surfaces of some alloys are heated *in vacuo;* metallic ions diffuse to the surface to form the more stable oxide by a solid-phase reaction.

Except for iron, chromium, and nickel alloys, complex oxides containing more than one metal do not form on the surfaces.

The occurrence of nickel oxide on copper-nickel alloys depends more upon the oxidation temperature than upon the composition of the alloy.

An empirical table of comparisons is given in graphical form showing the sums of the relative rates of formation and diffusion of the several ions based on the electron diffraction data. Predictions are made concerning the relative positions of ions in binary pairs which have not yet been studied.—PDA.

1.8, 3.5, 3.4, 3.7

Kinetics of the Reactions of Zirconium with O_2, N_2 and H_2. E. A. Gulbransen and K. F. Andrew. *J. of Metals,* **1,** No. 8, (Metals Transactions Section) 515-525 (1949) Aug. (*Trans. AIME* 185.)

Measurements of rates of reaction of zirconium with O_2, H_2 and N_2 over a wide range of temperatures and pressures and also in vacuo; stability of compounds formed. Results are correlated with fundamental rate theory and with the physical and chemical structure of the metal and the film.—BNF.

1.8, 3.5, 3.6

Chemical Properties of the Intermetallic Compounds Mg_2Sn and Mg_2Pb. W. D. Robertson and H. H. Uhlig. *J. Electrochem. Soc.,* 96, No. 1, 27-42 (1949) July.

Oxidation rates at high and low temperatures, galvanic potentials, rates of reaction in inorganic electrolytes, and a previously unreported form of crystallographic disintegration, occurring in distilled water and having a possible relation to stress corrosion cracking. For work by same authors on electrical properties see Metals Tech., **15,** No. 7 (1948) Oct.—BNF.

1.8, 3.2

Concept of the Hydrogen Potential in Steam-Metal Reactions. Carl A. Zapffe. *Trans. ASM,* **40,** 315-354 (1948).

The potential of hydrogen released as the result of the reaction of moisture with a metal depends upon the thermodynamic properties of the particular system and can be calculated from recorded thermodynamic measurements. This "hydrogen potential" is that pressure of hydrogen which would be generated within a closed system if the reaction proceeded to equilibrium without change in steam pressure. Since the absorption of hydrogen by metals is a function of the hydrogen pressure, these hydrogen potentials provide a basis for calculating the liability of the various metal systems to hydrogen pickup from the moisture reaction.

Calculations for iron, steel, stainless steel, nickel, chromium, manganese, silicon, aluminum, and magnesium are presented graphically and the significance of the curves is discussed. From calcu-

Only Experienced Men Handle the Job

at PLS to Give You Controlled Pipe Protection

Trained men put much of the control in PLS controlled pipe protection service.

It takes more than good equipment alone to turn out a good pipe coating job. The men who clean, prime, coat and wrap the pipe have been with PLS for years. This is one of our most valuable assets and your assurance of the best in pipe protection.

Precision equipment and uninterrupted "under-roof" operation are other control factors that give you more for your money in pipe protection at PLS.

PLS

PIPE LINE SERVICE CORPORATION

PIONEERS IN STEEL PIPE PROTECTION

General Offices and Plant: FRANKLIN PARK, ILLINOIS

Plants at Glenwillard, Penna. • Longview, Texas • Corpus Christi, Texas • Harvey, La. • Sparrows Point, Md.

PRIMARY SOURCES OF ABSTRACTS PUBLISHED IN CORROSION

AER—Aeronautical Engineering Review, Institute of Aeronautical Sciences, Inc. 2 East 64th St., New York 21, N. Y.
ALL—The Abstract Bulletin, Aluminum Laboratories, Ltd. P. O. Box 84, Kingston, Onatrio, Canada.
AWWA—Journal, American Water Works Association. Amer. Water Works Assoc., 500 5th Ave., New York 18, N. Y.
BLR—Battelle Library Review, Battelle Memorial Institute Library. 505 King Ave., Columbus, Ohio.
BNF—Bulletin; British Non-Ferrous Metals Research Association. 81-91 Euston St., London NW 1, England.
CALCO—Calco Chemical Division, American Cyanamid Corp. Bound Brook, New Jersey.
CE—Chemical Engineering, McGraw Hill Publishing Co. 330 W. 42nd St., New York 18, N. Y.
CEC—Consolidated Edison Co. of New York, Inc. 4 Irving Place, New York 3, New York.
EW—Electrical World, McGraw-Hill Publishing Co. 330 W. 42nd St., New York 18, N. Y.
GPC—General Petroleum Corp. of California. 2525 East 37th St., Los Angeles 11, Calif.
INCO—The International Nickel Co., Inc. 67 Wall Street, New York 5, New York.
IP—Institute of Petroleum. 26 Portland Place, London W#1, England.
MA—Metallurgical Abstracts, Institute of Metals, London, England. 4 Grosvenor Gardens, London SW 1, England.
ME—Marine Engineering, The Institute of Marine Engineers. 85/88 The Minories, London E. C. 3, England.
MR—Metals Review, American Society of Metals. 7301 Euclid Ave., Cleveland 3, Ohio.
NALCO—National Aluminate Corp. 6216 West 66th Place, Chicago 38, Illinois.
NBS—National Bureau of Standards. Supt. of Documents, U. S. Gov't Printing Office, Washington 25, D. C.
PDA—Prevention Deterioration Abstracts. National Research Council, 2101 Constitution Ave., Washington 25, D. C.
RA—Refrigeration Abstracts, American Society of Refrigeration Engineers. 40 West 40th St., New York 18, N. Y.
RM—Revue de Metallurgie, Paris, France. 5 Cite Pigalle, Paris (9e), France.
RPI—Review of Current Literature Relating to the Paint, Colour, Varnish and Allied Industries, Research Association of British Paint, Colour & Varnish Manufacturers, London. Waldegrave Rd., Teddington, Middlesex.
TDD—Technical Data Digest, Air Material Command—Technical Service Section, Central Air Documents Office, Wright-Patterson Air Force Base, Dayton, Ohio.
TIME—Transactions of Institute of Marine Engineers. 85 The Minories, London EC 3, England.
UOP—Universal Oil Products. 310 South Michigan Ave., Chicago, Illinois.
ZDA—Zinc Development Association. Lincoln House, Turl Street, Oxford, England.
No Code—Current Technical Literature, Bell Telephone Laboratories. 463 West Street, New York 14, New York.

lations obtained by a study of conditions over wide ranges of temperature, humidity, and steam pressure, numerous metallurgical phenomena can be readily explained. Among these are gassiness in stainless steels, siliconized iron and steel, pinhole porosity in magnesium and aluminum, anomalous low ductility in killed steels, decarburization of steam superheaters, embrittlement of steam boilers, and differences between steels made in summer and winter and between pig irons made in southern and northern climates.

Twenty-eight references are included. —PDA.

1.8, 4.3, 6.2

The Rate of Solution of High Purity Aluminum in Various Bases. M. E. Straumanis and N. Brakes. *J. of the Electrochem. Soc.*, **96,** No. 1, 21-26 (1949) July.

A series of dissolution experiments of high purity aluminum (99.998%) in KOH, $Ba(OH)_2$, $Sr(OH)_2$, $Ca(OH)_2$, $Mg(OH)_2$, and NH_4OH solutions of different concentrations was carried out. The reproducibility of the experiments was nearly the same as in the case of sodium hydroxide reported in a previous paper. For low concentrations, the rate of dissolution in monovalent bases increases with the cube root of the concentration, while in divalent bases, the rate increases as the square root of the concentration. At higher concentrations the rate of reaction is directly proportional to the concentration. The solution rate-concentration curve for NH_4 OH solutions does not follow either of these relationships. The dissolution in NH_4OH, $Mg(OH)_2$, CA$(OH)_2$, and Sr $(OH)_2$ is hampered by the formation of insoluble reaction products. In very dilute solutions, all the strong bases will act similarly, while at concentrations higher than normal the rate of attack decreases in the following order: NaOH, KOH, AND NH_4OH.—ALL.

1.8, 3.7, 4.3, 6.1

The Local-Cell Effect When Iron Dissolves in Hydrochloric Acid. K. Wickert and H. Pilz. *Arch. Metallkunde,* **2,** No. 6, 207-216 (1948).

Using the N_2-O_2 cell described in an earlier paper, a study was made of the influence of the surface condition on the solution of pure and Armco iron in normal hydrochloric acid. Specimens were prepared with surfaces of varying degrees of roughness ranging from treatment with a rough file to 0000 emery and subsequent polishing with magnesia. Some specimens were left in this condition, others were then picked in normal hydrochloric acid, and others were pickled, dried, and then left in air for periods up to 192 days or heated for 1-24 hours at 120° C or 1 hour at 250° C. The rate of attack of N HCl on the specimens was then determined. The results show that at the beginning of the solution process the solubility is very rapid, but soon decreases to a rate which is approximately linear in relation to time. The solubility is greatest with rough-filed specimens and decreases with increasing smoothness; the solubility rates are further decreased if the specimens have been pickled or oxidized. The solution process is discussed with reference to: 1) surfaces which are more or less covered with oxide films, 2) surfaces which have de la Rive type local elements, i.e., local elements with indirect electron transfer, and 3) surfaces which have highly reactive local elements, i.e., in which direct electron transfer occurs. It is concluded that, contrary to the views of F. Todt (see *Met. Abs.*, **15,** 507 (1948)), the determining factor in the high initial rates of solution of clean metal surfaces is not the presence of invisible oxide films but the degree of activity and the number of active localities present.—MA.

TESTING

• General

2.1, 1.8

Identification of Corrosion Products Using Measurements of Film Thickness and Mass. C. K. Eilerts. *Ind. and Eng. Chem.*, **41,** No. 8, 1716-1717 (1949) Aug.

The work of Hackerman and Schmidt suggests that products of corrosion may be partially identified by the density of the surface layers formed on the test coupons. Their microscope procedure used in determining the average thickness of the surface layers provided a measure of the volume of the corrosion product in an area of 100 sq. cm. Determining the weight loss of the coupons on exposure both before and after they were descaled provided a measure of the mass of the corrosion product in the same area. Densities computed from the mass and the volume of the corrosion product agree for the most part with those given in the literature for the compounds identified by X-ray analysis. The measured values of surface layers thickness given by Hackerman and Schmidt and the difference in the computed values of the pairs of the equations have been used in the following equation to estimate the density of the corrosion products:

$$100\ (10^{-4}h)d = \gamma' - \gamma$$

where:

h = thickness of the surface layer, μ
d = density of corrosion products, grams per ml.
γ = weight loss of coupons as removed, grams per 100 sq. cm.
γ' = weight loss of coupons after descaling, grams per 100 sq. cm.

Close agreement between the measured values of corrosion product density and the literature values for product identified by X-ray analysis was noted. Assuming that film thickness measurements made by means of the microscope would not be more accurate than $\pm 0.3\ \mu$ the uncertainty reflected in most of the density computations would be 3 to 7%. Computed values of density would not show the respective amounts of each of three or more compounds present in a corrosion product but might distinguish between the oxides and ferrous carbonate.—ALL.

• On Location Tests

2.2, 3.5, 8.9

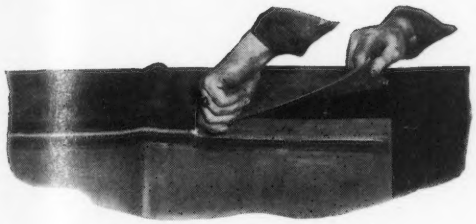
Fatigue Tests of Manganese Steel. R. S. Jensen. *Bull. Amer. Ry. Eng. Assn.*, **50,** 579-588 (1949) Feb. *Applied Mechanics Reviews*, **2,** No. 8, 179-180 (1949) Aug.

Results of reversed bending tests at 800 cps on flat specimens with a T-shaped test cross section, made from Hadfield manganese steel. Test conditions were chosen to correspond to the working conditions for a rail-crossing part, and included the influence of the surface treatment and of corrosion on an unprotected and on a coated surface of the specimen. In all tests the maximum tensile stress had a ratio of 0.5 to the max. compressive stress. Tests without corrosion and the corrosion tests on coated specimens were carried out to 10 million cycles. The beneficial effect of shot peening in increasing the fatigue life of the specimens without corrosion and of the coated specimens under acid corrosion is particularly remarkable. In the corrosion fatigue tests with unprotected specimens, specimens with surface treatments withstood about the same stress for 1 million cycles.—INCO.

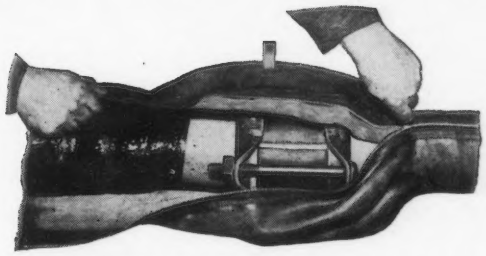
2.2, 3.5, 6.1, 7.1

Experimental Study of the Resistance of Different Steels to Erosion by Cavita-

Now—you simply "pull the zipper" on corrosion problems



Dresser ZIPCOAT for welded joints zips over weld area, fits closely to the pipe. 30″ lengths.



Dresser ZIPCOAT for couplings is easy to install over joint and pipe ends—all in one quick operation. Has bleeder valve to vent air during backfilling.

NEW DRESSER ZIPCOATS* GIVE SURE PROTECTION, SUPERLATIVE DIELECTRIC STRENGTH

"As easy as zipping up a jacket" is what workmen say about Dresser's new ZIPCOATS. They install ZIPCOATS in 1/10 of the time it takes to coat a joint. You get protection that equals or exceeds that offered by the mill or yard-wrapped pipe.

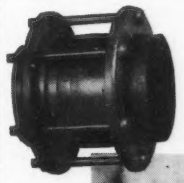
And look at the hazards you avoid: there's no flame; no heating, hauling or messy application of hot stuff; no danger from fumes or burns.

Can be installed in any weather.

Write today for descriptive material and price list.

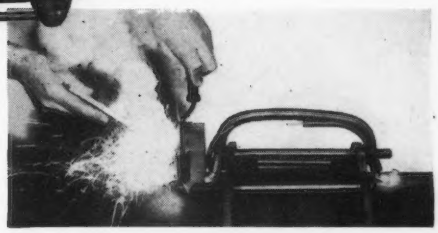
*Every ZIPCOAT complete with anaerobic microbiological corrosion inhibitor and cold sealing compound. ZIPCOAT is a trade mark of Dresser Manufacturing Division.

Dresser ZIPCOAT for insulating joints is made like the ZIPCOAT for welds, but in ten-foot lengths. Installing one on each side of an insulating joint that's protected with a ZIPCOAT for couplings gives ultimate protection. Eliminates costly boxing and filling with dope. Immediate trench backfill saves time.



Install Dresser Insulating Couplings IN MINUTES

Dresser Style 39 Insulating Couplings with new plastic gaskets insulate effectively and are the simplest insulating type joint to install. Sizes ¾″ to 30″ and up.



New Dresser Bonding Method saves up to 50% of cost; materials preformed

Fast bonding, giving low resistance with *pre*formed Dresser Bond and 5-second chemical welding method. Needs no special skill, no bulky equipment. Makes homogeneous weld area, eliminates surface contact variables. Compact kit of 50 *pre*formed bonds includes all materials needed for installing.

DRESSER

MANUFACTURING DIVISION

Headquarters: Bradford, Pa. (One of the Dresser Industries). Sales Offices: New York, Philadelphia, Chicago, Houston, San Francisco. In Canada: 629 Adelaide St., W., Toronto, Ontario.

tion. S. Saito. *Trans. Soc. Mech. Eng.* Japan, **9,** 11157-11162 (1943) Nov. *Centre de Documentation Siderurgic,* 1948, traduction No. 576. *Circulaire d'Information Techniques,* **5,** 505-521 (1948) Dec. *J. Iron Steel Inst.,* **162,** Pt. 4, 490 (1949) Aug.

An account is given of tests with four steels used for ships' turbines to determine their resistance to erosion. The method of testing is described and the results obtained are presented in graph form.—INCO.

2.2, 4.3, 2.3

Corrosion of Steel in Sulfur-Producing Tubes. Frasch Process. D. A. Shook and N. Hackerman, Univ. of Texas. *Ind. & Eng. Chem.,* **43,** No. 9, 1974-1977 (1949) Sept.

Test coupons were exposed in a container placed in the flow line from a sulfur well. Rates of corrosion were found to vary with variation in production conditions. The rate was negligible in presence of sulfur alone but increased during water contacting periods in presence of sulfur. Rate and nature of attack were reproduced in laboratory by a simple bomb reactor. Conclusions given on basis of field experiments were corroborated by laboratory work.—INCO.

• Laboratory Methods

2.3, 2.4, 3.5

Gas-Metal Reactions, Part I. A. Dravnieks and H. J. McDonald. *The Iron Age,* **164,** No. 8, 78-82 (1949) Aug. 25.

Corrosive action of various gases often neutralizes the ability of an alloy to retain high mechanical strength at elevated temperatures. The authors discuss an investigation of gas-metal reactions where the products of interaction are nonvolatile and form scale on the surface of the metal. Utilization of X-ray, electron diffraction, radioactive tracer and electrical methods in studying reaction products are described, and techniques for measuring gas-metal reaction rates are explored.—ALL.

2.3, 3.3

Corrosion. M. G. Fontana. *Ind. & Eng. Chem.,* **41,** No. 9, 73A-74A (1949) Sept.

Discussion of the value of the boiling 65% HNO_3 test to predict corrosion of stainless steel in other environments.—INCO.

2.3, 5.3

A Note on the Measurement of Plating Thickness. C. H. R. Gentry, Phillips Electrical Ltd., Mitcham Junction, Eng. *Analyst,* **73,** 157-158 (1948) March.

A proposed modification of the jet test method for measuring plating thicknesses is more accurate, more rapid than former methods and provides a check on the qualitative nature of the coating. It is based upon the detection of the penetration point by recording a change in the potential of the plated article when the underlying metal becomes exposed as a result of contact with a jet of reagent solution.

In the original jet test of the British Non-Ferrous Research Association it is necessary to interrupt the flow of the liquid at regular short intervals to look for the first, often barely detectable signs of penetration of the plating and to make frequent spot tests to detect the underlying metal. In the modified test, the penetration point can be detected without stopping the flow of liquid and without examining the sample by measuring the emf of the cell formed by the half cell and a suitable reference electrode in the bulk of the reagent solution. The time necessary for penetration of the coating is read from a stop watch which is started simultaneously with the flow of the jet solution and stopped on the first sign of closing of the magic-eye of the titration apparatus.

A saturated calomel cell is contacted as a reference electrode with the reagent solution through a salt bridge and connected with a crocodile clip to a Mullard Electrometric Titration Apparatus, Type E. 920, which is sensitive to 2 mv. For cadmium and zinc coatings, the clip is connected to the negative, for nickel platings to the positive terminal. Preliminary tests with rather thick coatings are made to determine the initial setting of the potentiometer dials. Typical settings are 830 mv for zinc plating with No. 4 solution, 685 mv for cadmium plating with No. 3 solution, and 200 mv for nickel coatings with F. C. solution.

Incorrect labeling of platings can be detected immediately because of widely differing initial emf values.—PDA.

2.3, 3.5

Method for Measuring the Electrometive Force in Friction and Wear. M. L. Goldovskii. *Zavodskaya Laboratoriya,* **15,** No. 3, 380 (1949).

Description of apparatus developed by author for measurement of emf created in static friction between metals with and without lubricant. Operation of apparatus and preparation of surface of friction for microstudies of phenomena of friction and wear with "dry" and lubricated metals are discussed.—INCO.

2.3, 4.4, 8.9

The Beaker-Corrosion Test for Lubricating Oils. F. W. H. Matthews. *Jr. Inst. of Petro.,* **35,** 436-53 (1949).

The author describes a laboratory test for evaluating the corrosive potentialities of lubricating oils towards cadmium-nickel bearing metal. The work provides a "background picture" for the work at present being done by I. P. Sub-committee No. 6 on corrosion tests for automotive lubricants. The experimental work is described in some detail. Its object was to provide a test of suitable precision which at the same time would yield results correlating with those obtained by the Bristol single-cylinder Hercules engine test. The test finally adopted yielded reproducible results showing reasonable correlation with engine tests. The apparatus and the procedure are described fully, with explanatory diagrams and photographs.

2.3, 4.6

How to Use Color Control Tests for Boiler Water. F. R. McCrumb, W. A. Taylor and Co. *Power Generation,* **52,** No. 5, 60-61 +(1948) May.

Description of simple color comparactors, in which treated sample color is matched against standard colors and values read in ppm. Discussion on how to use color tests for phosphates, silica, pH, nitrates, steam condensate, and polyphosphates, and why tests are needed.—INCO.

2.3, 4.1, 3.6

Conference on Electrochemistry and Corrosion Research at the Berlin Technical University on 23 July, 1948. *Metalloberflache,* **2,** No. 11, 248-249 (1948); discussion, 249.

F. Todt spoke on the electrochemical properties of oxide coatings on metal surfaces and described an eletrochemical method for measuring the rate of atmospheric oxidation of metals, which also enables a quantitative estimation to be made of the local-element effect between metal and oxide.

2.3, 6.2

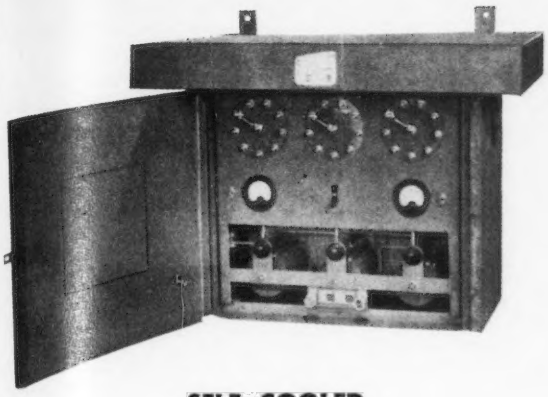
Demonstration Reagent for Corrosion of Aluminum. W. L. Orr. *Jr. of Chemical Education,* **26,** No. 5, 267-268 (1949) May.

A reagent was developed for demonstrating the mechanism of corrosion in aluminum using "Aluminon" (aurin tricarboxylic acid) and thymol blue as indicators. Aluminon develops a red color in the presence of aluminum ions, indicating the anodic areas in the corrosion of aluminum. The thymol blue changes from a pale yellow to a blue over the pH interval of 8.0 to 9.0 and develops a blue color in the area of the cathodic reaction. To prepare the reagent, one gram of sodium chloride and 1.3 g. of agar are gently boiled in 100 ml. of water for about an hour to peptize the agar, and then filtered through a cloth. Then 13 ml. of Aluminon reagent made by dissolving 0.1 gram of Aluminon in 100 ml. of water, and 15 ml. of thymol blue indicator solution, are added and the pH is adjusted to 8, or just short of the formation of a blue color, with dilute sodium hydroxide. A piece of aluminum wire or other aluminum object is then placed on a foundation layer of cooled reagent in a suitable container and more reagent is added to cover it completely. The reagent should not be too hot as distortion of the color zones may appear. Color development usually requires several hours, so that samples may be prepared one day, for observation the next. A piece of aluminum wire shows color development after twelve hours with anodic reaction at the ends where strains were introduced in cutting, and blue color showing the cathodic zone covering most of the area between. Effect of strain can also be shown by bending a piece of wire or filing notches in it. Colors develop much faster when copper wire is wound around aluminum, showing how contact with a less active metal accelerates corrosion. A notch through the clad surface of a piece of Alclad illustrates how the pure aluminum coating protects the main stock. All demonstrations are illustrated with drawings.—ALL.

2.3, 2.2, 6.1

Results of Some Plant Corrosion Tests of Welded Stainless Steels. G. F. Comstock, ASTM Reprint No. 23, 10 pp. (1949).

Corrosion tests of welded stainless steels were made in a number of chemical plants under regular operating conditions, and the results compared with those obtained on the same steels tested by the standard boiling nitric acid procedure in the laboratory. Steel specimens included types 304, 321, and 347 sheets, welded with types 308, 321 and 347 electrodes, respectively, and tested both in the as-welded and stress-relieved conditions. The results show no correlation between the standard nitric acid test and the plant corrosion tests. In the latter there were no significant differences



SELF COOLED

GOOD-ALL

SELENIUM RECTIFIERS

In Addition to Our Standard

Self Cooled and Oil Immersed Models

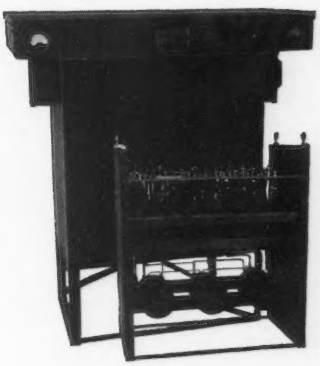
THE NEW "ADD A STACK" RECTIFIER

Add One—Two—Three—Total of Four Stacks

5 NEW MODELS

Write for

F O L D E R



OIL IMMERSED

GOOD-ALL ELECTRIC MFG. CO.

OGALLALA NEBRASKA

PHONES 112 OR 113

between the results from type 321 steel and those from type 347 steel. A number of instances are reported where welded type 304 stainless steel served in a satisfactory manner when exposed in chemical plants to conditions where the previous inclination would be to use a stabilized grade. Diagrams and tables.

CORROSION TYPES & INFLUENCING FACTORS

• General

3.1, 3.7, 3.4

What Causes Localized Corrosion? *Steel,* **124,** No. 11, 86-89, 128 (1949) March 14.

Localized corrosion of metal surfaces is often attributed to the presence of impurities in the corroding metal. However, there are a number of other causes which are of far more practical importance than impurities or constituents. Other known possible causes are: 1. Metallurgical factors, including grain boundaries, orientation of grains, differential grain size, and differential heat treatment; 2. Surface roughness, including local scratches and abrasions; 3. Differential strain; 4. Differential pre-exposure to air or oxygen; 5. Differences in degree of aeration, heating illumination and agitation; 6. Difference in shape and contact with dissimilar metal; 7. Certain complex cells may influence the corrosion factor and externally applied potentials have been found to be responsible for certain severe cases of corrosion. A discussion of each of the causes named above is included in the article.—ALL.

• Types

3.2, 3.7, 3.4, 6.1

Peeling of Malleable Iron. *Engineering,* **165,** 343 (1948) April.

Five papers on the peeling of whiteheart malleable cast iron and one paper on the penetration of sulfide in the carburization of steel are briefly reviewed.

Peeling is caused by the occasional formation, during malleablizing, of a film of iron sulfide below the surface of the finished casting. This film is associated with a certain amount of intercrystalline oxidation, producing a weak surface layer which becomes readily detached from the remainder of the casting when stress is applied. Peel defects in castings are not easy to detect by usual inspection tests and may lead to fatal accidents, since whiteheart malleable castings are used as track links on carrier vehicles.

Since a high sulfur content in the ore was an evident cause of peeling, some improvement could be obtained by substituting a low-sulfur ore, 0.01% sulfur, for Riff ore containing an average of 0.14% sulfur, or by diluting the spent ore with granite chippings.

A clearer insight into the mechanism of decarburization of iron was obtained by malleablizing white cast iron samples in controlled experimental atmospheres containing carbon monoxide and dioxide and sulfur dioxide. The results of these and similar experiments showed that peeling can be minimized by reducing the harmful carbon monoxide content, viz., 1) using an annealing ore mixture having a high ferric oxide content and a large bulk density, 2) maintaining a mildly oxidizing furnace atmosphere, and 3) avoiding a smoky flame and any reducing conditions during annealing.

The sulfur and silicon content should be kept as low as possible, the latter as low as consistent with satisfactory malleablizing; the initial carbon content and the manganese content should be relatively high, the latter up to 0.4%.

Peeling is also influenced by the temperature and duration of annealing, and factors favoring the formation of peel tend to increase the depth of sulfide penetration. Sulfide penetration into steel under carburizing conditions involves the formation of a molten sulfide on the surface and then its entry into the metal by dissolving iron on one side and rejecting it on the other. This cannot occur below the melting point of the iron—iron sulfide eutectic, 985° C in air and not lower than 960° C in oxygen. In high-silicon steels the sulfide formation is associated with internal oxidation. Carbon, manganese, and silicon in the iron generally decrease the rate of penetration of the sulfide band by increasing its degree of dispersion until it no longer presents a barrier to the carbon.—PDA.

3.2, 3.7, 6.1

Influence of Steel Structure Upon Diffusion of Hydrogen in Steel. S. S. Nesyreva. *Stal.,* **8,** No. 6, 542-544 (1948).

Solubility of hydrogen and rate of diffusion of hydrogen in steel as functions of chemical composition and steel structure are described. Explanation of sensitivity of alloy steels to flaking, ability of steel structure to keep susceptibility to flaking at a minimum, and data on solubility of hydrogen in Armco iron, 18-8, transformer steel, and carbon steel (different structures) are discussed.—INCO.

3.2, 2.3, 8.8

Hydrogen Embrittlement in Copper Electroplating. C. A. Zapffe and M. E. Haslem. *Plating,* **36,** No. 9, 906-913+ (1949) Sept.

A special bend test for studying H_2 embrittlement of steels exposed to hydrogenizing conditions is applied to various copper electroplating processes. Both mild steel, SAE 1020, and stainless steel, AISI 440-C, are used as cathodes, and certain principal electroplating processes are studied. Results prove that absorption of H_2 by cathode is quite independent of total amount of H_2 deposited, such that all metal plating processes studied cause at least as much, and generally more, embrittlement than H_2 plating itself. Copper plating belongs with cadmium plating, and often with chromium plating, as a factor deserving the closest consideration in plant failures that occur in such fabricating operations as wire drawing and cold-upsetting where copper plate is applied previous to coldworking. Similarly, problems ity in the plate itself should be carefully reviewed with regard to the often unsuspected scope of H_2 activity demonstrated by this research. A phenomenon in recovery of the plated articles is also observed in which all specimens at the end of a period of 33 months had recovered a 180° bend except stainless steel having an acid-copper plate applied over a cyanide-copper strike, which showed very little recovery. 17 references.—INCO.

• Factors Biological

3.3, 6.3

Specificity of Microbiological Attack on Cellulose Derivatives. R. G. H. Siu, R. T. Darby, P. R. Burkholder and E. S. Barghoorn. *Text. Res. J.,* 19, No. 8, 484-488 (1949) Aug.

Data have been presented relating to the growth of 11 species of micro-organisms isolated from deteriorated cotton fabrics on various derivatives of glucose, mannose, cellobiose, and cellulose. A high degree of specificity was exhibited. As long as there was at least one firmly bound substituent in every anhydroglucose unit, the resulting derivative was not susceptible to microbiological attack. Under such conditions the nature of the substituent has relatively little influence on the degree of resistance imparted. This was considered to be promising theoretical support for the underlying premise on which the idea of multipurpose topochemical reactions as a means of mildewproofing cotton fabrics was proposed.—TDD.

• Physical and Mechanical

3.5, 1.8, 2.3

The Fatigue of Metals. P. T. Arthur. *Pract. Eng.,* **16,** No. 414, 610 (1948).

An account is given of the mechanism of fatigue, the corrosion-fatigue failure of metals, fractures produced, and conventional methods of fatigue testing.—MA.

3.5, 3.7, 6.1

Heat-Resisting Cast Iron. G. Clas and K. Houben. *Neue Giesserei,* **36,** 131-138 (1949) May. *Bull. BCIRA.,* 10, 23 (1949) July.

Study of service behavior of aluminum, chromium, and silicon cast irons under exposure to high temperatures. Discusses the unsatisfactory behavior of chromium cast iron in blast-furnace gas at 450°-550° C, and the favorable influence of aluminum on resistance of alloy cast iron to temperatures up to 700° C.—INCO.

3.5, 4.3, 3.7, 2.3

Corrosion at Elevated Temperatures and Pressures. M. G. Fontana, Ohio State Univ. *Alloy Casting Bull.,* **1949,** No. 13, 5-6 Aug.

Brief description of some results of study of corrosion by chemicals and other reagents at elevated temperatures and pressures. Quenched-annealed CF-8 in 65% HNO_3 showed a corrosion rate of 500 mils per year at 375° F. Quench-annealed specimens heat-treated by quenching in water from 2000° F showed a corrosion rate of 16 mils per year in standard ASTM boiling 65% HNO_3 test. Tests were made on cast titanium and showed that all the corrosion rates are less than 5 mils per year.—INCO.

3.5, 1.8, 3.6

Investigation of Cavitation Corrosion. G. Petracchi. *La Metallurgia Italiana,* 41, No. 1, 1-6 (1949) Jan.-Feb. *Eng. Dig.,* 10, No. 9, 314-316 (1949) Sept.

Discussion includes hypothesis on the

CORROSION

Guardian OF INDUSTRY'S PHYSICAL ASSETS

The constant attack of corrosion on all of industry's physical assets—pipelines, plants, equipment—is costing American industry billions of dollars each year. Combating this waste, and assuming more and more responsibility for protection against such industrial loss, is the increasingly important corrosion engineer.

To properly perform his job, the corrosion engineer uses various types of coatings, wrappings and electrical and application equipment ... and draws upon the combined knowledge of such organizations as the National Association of Corrosion Engineers. Among the *proven* products he uses are Coal Tar Protective Coatings.

Pittsburgh Coke & Chemical Company produces a complete line of such coatings which corrosion men have found dependable, uniform and of unsurpassed quality. Produced by the company from coal tar and other ingredients originating in its integrated, one-location operations, the coatings contain no water solubles, have high dielectric properties ... and can be economically applied.

You will find Pittsburgh Coke & Chemical Company Coatings admirably suited for any corrosion need. Your inquiries are invited.

STANDARD GRADE
Mineral filled coal tar pitch of highest quality, exceeding industry specifications.
(Aluminum Drum)

MODIFIED GRADE
Semi-plasticized; a good, tough general-purpose coating.
(Yellow Drum)

PLASTICIZED GRADE
Fully plasticized; the premium product made from coal tar base; toughest, most durable coating available.
(Red Drum)

Protective Coatings Division of

PITTSBURGH COKE & CHEMICAL COMPANY

1979 Grant Building ... Pittsburgh 19, Pa.

OFFICES: PITTSBURGH · NEW YORK · LOS ANGELES · HOUSTON · TULSA

fundamental causes of cavitation corrosion and description of tests. With regard to cavitation corrosion, the major factor is that the specimen can operate as an anode and as a cathode. Electric currents are generated by microcells formed in adjacent crystals, as a result of alternating mechanical stresses and the motion of the liquid. Cavitation is not initially destructive because of mechanical stresses to which it gives rise, but because these stresses are associated with a corrosive action which is primarily due to electrical effects. Illustrations are included.—INCO.

The Stress Corrosion Behavior of Hy 43 and Igedur Extruded Strip with Various Additions. G. Siebel (In German). *Z. Metallkunde,* **40,** No. 5, 162-166 (1949) May.

Copper, manganese, chromium, vanadium and titanium noticeably improve the resistance to stress corrosion of extruded strip Hy 43 (aluminum-4.5 zinc-3.5 magnesium); heat-treatment up to 500° causes only slight deterioration, as distinct from usual results with sheet. Manganese, chromium and titanium similarly improved Igedur (aluminum - copper - magnesium) extruded strip, but to a lesser extent.—BNF.

3.5, 3.4, 4.2, 4.3

Stress-Corrosion (of Copper-Base Alloys). A. W. Tracey and D. H. Thompson. *Metal Ind.,* **74,** No. 23, 466 (1949).

The role of carbon dioxide in stress-corrosion is to form a hygroscopic film of corrosion products, and this film then attracts moisture, which aids the progress of corrosion.—MA.

• Factors Metallurgical

3.7, 6.2, 2.3

Investigations into Corrosion-Resisting Cast Chromium-Nickel Steel with Special Reference to the Sigma Phase. Eisermann and W. Felix. *Sulzer Tech. Rev.,* **1949,** No. 2, 1-8.

Influence of heat treatment on formation of sigma-phase in a corrosion-resisting chromium-nickel-molybdenum cast steel of Type 317, was investigated in series of mechanical, magnetic and microscopic tests. From room temperature up to about 950° C, the steel is in $\gamma + \sigma$ state. Above 950° C, the σ-phase diminishes with rising temperature, while new ferrite is formed, giving $\gamma + \sigma + \alpha$ state. At 1100-1150° C, the σ-phase disappears completely leaving $\gamma + \alpha$ region. By means of sufficiently rapid cooling from $\gamma + \alpha$ region, σ-separation can be prevented and the austenitic-ferritic structure cooled to room temperature, but the undercooled ferrite is unstable. The σ-formation causes a considerable loss of toughness in steel, while hardness is only slightly influenced. Test results show that steel Type 317 is not suitable for use in castings or at any rate not in cases where it cannot be submitted to suitable heat treatment.—INCO.

3.7, 4.6

Steam Atmosphere Used to Heat Treat and Improve Surface Properties. F. L. Spangler. *Mat. and Meth.,* **20,** No. 5, 56-58 (1949) May.

Many ferrous and non-ferrous materials can be processed at temperatures up to 1000° F (538° C) in steam atmospheres to produce a thin, clear, and tenacious oxide film on the surface. The four general steps applicable to the treatment of ferrous materials include: 1) The work, after being loaded in the furnace, is preheated with a normal air atmosphere to a temperature of 650 to 750° F (343 to 399° C). This prevents condensation of steam on the cold work. 2) When furnace reaches the preheat control temperature, the furnace is purged of air as rapidly as possible by incoming steam. Purging time is approximately half an hour and about 50 volume changes are required. 3) The load is then heated to the final treating temperature and soaked for the required time with steam continuously flowing through the furnace. 4) Parts are removed from the furnace and either air cooled or liquid quenched. The same basic steps are used to treat nonferrous materials; however, times and temperatures differ, depending on the particular metal being treated. Work must be cleaned properly before loading into the furnace—either by vapor degreasing or by alkali baths followed by hot water rinsing. Steam treatment produces a better surface finish, improves machinability and provides a scale-free tempering process. On non-ferrous metals, the steam atmosphere inhibits oxidation and prevents discoloration and scaling. On iron and steels, blue magnetic iron oxide, Fe_3O_4 is formed. Steam atmosphere has been used for the heat treating of aluminum clutch arms that fit into Micromax recorders. The arm is made of 61 SO aluminum alloy. The final processing steps on the clutch arm involve a solution heat treatment at 970° F (521° C) for half an hour, followed by a water quench. A final coining operation follows, after which it is given a low temperature age hardening treatment in air. Formerly the solution heat treatment was done in an air atmosphere, causing a white matte appearance which required extensive buffing to remove. Steam heat treatment causes a mottled gray finish which can be readily buffed.—ALL.

CORROSIVE ENVIRONMENTS

• General

4.1

Reactions Accelerating the Corrosion of Lead in Cement. M. Dodero. *Metaux et Corrosion,* **24,** No. 282, 50-56 (1949) Feb. (In French.)

Corrosion is accelerated by the increase in electrical conductivity of cement when it becomes damp, and by direct and alternating stray currents; the potential between the lead-iron and also other lead-metal couples cause corrosion of lead.—BNF.

• Atmospheric

4.2, 3.7, 6.2

Physical and Electrical Properties of Calcium. A. H. Everts and G. D. Bagley, Union Carbide & Carbon Co. Paper Before Electrochem. Soc., Ohio Mtg., Columbus, Apr. 14-17, 1948. *J. Electrochem. Soc.,* **93,** No. 6, 265-271 (1948) June.

New determinations of physical and electrical properties of calcium were made for comparison with values given. High-purity calcium was melted and cast into a slab in atmosphere of argon gas. Slab was cut into bars and rolled into sheets and rod without annealing. Specimens of both were annealed later and exposed to atmosphere but protected from rain and wind. After 6 months, sheet was corroded through in small areas. Corrosion seemed to progress in uniform rate from both sides.—INCO.

4.2, 6.2

Resistance of Magnesium Alloys to Corrosion. *Magazine of Magnesium,* 1949 p. 13, May.

Qualitative rating for the various alloys with respect to indoor and outdoor atmospheres and sea water.—MR.

4.2, 6.1

Why Pipe Corroded Only on One Side of the Building. T. W. Reynolds, Abbott, Merkt & Co. *Heat. & Vent.,* 45, No. 6, 98 (1948) June.

Action of soot from a chimney near by caused corrosion of a galvanized steel pipe in a vertical line, due to fact that the soot picks up water and is deposited along one side of the pipe. The pipe on the lower floors of the building suffered more severe corrosion due to more soot.—INCO.

4.2, 2.2, 2.3, 6.2

The Effect of Natural Weather Conditions on the Stress Corrosion of Aluminum Alloys. G. Schikorr and G. Wasserman. (In German.) *Z. Metallkunde,* 40, No. 6, 201-205 (1949).

Loop specimens of aluminum-copper-magnesium and aluminum-zinc-magnesium alloys were tested at 17 different stations representing industrial, urban, marine and rural atmospheres. Laboratory tests in 3% sodium-chlorine solution at 70° C showed qualitative agreement only.—BNF.

• Chemicals Inorganic

4.3, 2.2, 2.3, 7.3

Corrosion of Mild Steel by Sulphuric Acid. H. R. Archer and J. Howlett. *Chem. & Ind.,* **1949,** No. 35, 605-607, Aug. 27.

Laboratory tests in 98%-65% sulfuric acid, and plant tests with mild steel tubes and pump valve assemblies in 75% H_2SO_4.—BNF.

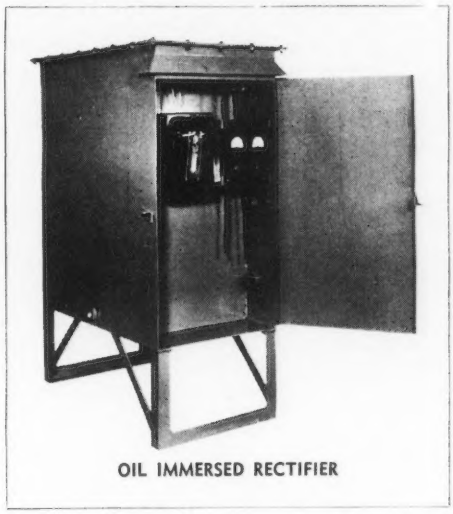
4.3, 7.5, 8.8, 6.1

Stainless Steel Moves Into Nitric Acid Container Business. *Chem. Eng.,* **56,** No. 9, 175 (1949) Sept.

The Metal Packages Comm. of the Manufacturing Chemists' Assn. have been cooperating with fabricators of stainless steel containers in an effort to develop a satisfactory container for nitric acid. As a result Niles Steel Products Div. of Republic Steel Corp. is prepared to manufacture 15-20 gal. stainless steel drums. These containers are of the conventional 3-piece drum construction and comply with requirements of ICC Spec. 5C. A pouring device consisting of a piece of threaded stainless steel pipe which is screwed into the single 2-in. opening is available. Heinz Manufacturing Co. has developed a 16-gage stainless steel (Type 304) 3 piece inert-shielded arc welded container that closely resembles the beer barrel. The Detroit Cooperage Co. have available a 3 piece helio arc welded container with

DEPENDABLE

CATHODIC PROTECTION EQUIPMENT



OIL IMMERSED RECTIFIER

THERMO-ELECTRIC GENERATOR

•

ELECTROLYSIS SWITCH

•

AIR COOLED RECTIFIERS

•

OIL IMMERSED RECTIFIERS

The C.S.C. Thermo Electric Generator generates electric current by the use of gas from gas transmission lines. Develops 50 watts of constant current.

The C.S.C. Electrolysis Switch is used on pipe lines and other underground structures to control stray current. Operates continuously or intermittently according to demand.

C.S.C. Selenium Rectifiers are manufactured in a complete range of sizes and capacities in both oil immersed and air cooled models. Rugged construction assures long operational life.

ALL C.S.C. RECTIFIERS ARE UNCONDITIONALLY GUARANTEED

FOUR WEEKS DELIVERY

Write us for new descriptive catalogs

CATHODIC SERVICING COMPANY

1024 NORTH OLIE STREET **PHONE 7-5890** **OKLAHOMA CITY, OKLAHOMA**

a single head opening and with welded foot ring protection for both heads. The expanded hoops are so formed that the gage of the metal is actually increased over the top of the crown.—INCO.

Influence of Impurities on the Corrosion of Lead. (In French) Henri Guiter. *Bulletin de la Societe Chimique de France,* 74-76 (1947) Feb.

All of the investigated impurities, with the exception of mercury, increased the rate of lead corrosion in nitric acid. The rate decreases when the concentration of the impurities is lowered.—BLR.

Metallic Alloys Resistant to Hydrochloric Acid. N. I. Gel'perin and others. (In Russian) *Zh. Prikhladnoi Khimii,* **22,** No. 1, 45-55 (1949) Jan.

Discusses previous work by other investigators and reports experiments by the authors on corrosion resistance of alloys to hydrogen chloride, hydrogen bromide and formic acid solutions at temperatures up to 190° C. Alloys mentioned include Hastelloy A and B; SK-1 and SK-2 (both nickel-molybdenum-chromium-iron base; SK-3 (nickel-silicon-molybdenum base).—BNF.

Corrosion. M. G. Fontana. *Ind. Eng. Chem.,* **41,** 77A-78A (1949) Aug.

Data obtained in study of corrosion by liquid media at elevated temperatures and pressures is presented on CF-8 (18-8S type alloy) and titanium in HNO_3 at high temperatures. Examples of surprisingly high corrosion on CF-8 in 65% HNO_3 at 375° F and of surprisingly low rate of attack on cast titanium in 65% HNO_3 at 335° F are described.—INCO.

Fluorine in Industry—Part II: Industrial Fluorine Chemistry. J. C. Finger and F. H. Reed. *Chem. Ind.,* **64,** No. 1, 51-56 (1949) Jan.

Concentrations of hydrofluoric acid above 60% can be handled in iron as well as magnesium, copper, Monel, nickel, and brass. The use of anhydrous hydrogen fluoride as a stripping agent in salvaging steel from defective enamels is discussed.—INCO.

Means for Preventing Hydrocyanic Acid Corrosion of High-Pressure Gas Cylinders. (In German) Constanz Eymann. *Gas—und Wasserfach,* **89,** No. 6, 183-187 (1948).

Traces the cause of stress corrosion to hydrogen cyanide, discusses the customary methods of drying gases, and describes a method by means of which practically all the hydrogen cyanide can be removed from the gas by reaction with H_2S, NH_3, and O_2.—BLR.

Concerning the Dissolution of Platinum Foil in Aqua Regia. (In French) Clement Courty. *Bulletin de la Societe Chemique de France,* **1948,** 1152-1154, Nov.-Dec.

Silver, gold, iridium, and copper impurities in polished platinum foil produces curious phenomena in the dissolution of the foil in aqua regia. Data concerning rates of dissolution are tabulated.—BLR.

Corrosion by Commercial Sodium Hypochlorites and Its Inhibition. G. H. Botham and G. A. Dummett. *Jnl. Dairy Res.,* **16,** 23-28 (1949) Jan.

Commercial sodium hypochlorites are shown to corrode aluminum, tinned copper, nickel silver and cast stainless steel (18 chromium, 8 copper, 3 molybdenum). If $KMnO_4$ is present, 18-8 chromium-nickel steel is also attacked. The corrosion can be inhibited by addition of sodium silicates, with some impairment of bactericidal efficiency of the solution. —INCO.

• Chemicals Organic

Fatty Acids versus Construction Materials. *Chem. Eng.,* **56,** No. 4, 217, 218+, No. 5, 263-4+, No. 6, 243-244, No. 7, 237-238+ (1949) Apr., May, June, July.

Part I includes "Glass-Lined Steel," by S. W. McCann; "Carbon and Graphite," by W. W. Palmquist; "Stainless Steel," by G. L. Snair; "Hastelloy Alloys," by C. G. Chisholm. Part II comprises "Rubber Lining," by O. S. True; "Porcelain," by J. S. Chowning; "Chlorimet" by W. A. Luce; "Iron and Steel," by A. W. Spitz; "Worthite," by W. E. Pratt. Part III covers "High-Silicon Irons," by W. A. Luce; "Aluminum," by E. D. Verink, Jr. Part IV deals with "Chemical Stoneware," by F. E. Herstein; "Nickel and Nickel Alloys," by W. Z. Friend; "Durimet-20," by W. A. Luce.—BNF.

Equipment and Construction Materials for Fatty Acids. *Chem. Eng.,* **55,** No. 11, 103-4 (1948).

Recent installations make more extensive use of stainless steel, stainless clad steel, aluminum, nickel and Monel. This has been particularly true in the case of stills, condensers, separators and pipelines. There is a trend away from copper and high-copper alloys, especially in the final processing of soaps. A flow diagram is given.—RPI.

Role de l'Attaque du Metal par les Acides Gras a Longue Chaine Dans le Frottement Onctueux. (The Part Played in Lubrication by the Attack of Long Chain Fatty Acids on Metal.) (In Franch) J. Pomey and F. Lowry. *Metaux et Corrosion* (France), **24,** No. 285, 135-44 (1949) May 8.

A report on research done over ten years ago, but previously unpublished. It confirms English work on the mechanism of lubrication and the behavior of metals under friction, and contributes to knowledge of the corrosion of metals by the long chain fatty acids present in lubricants. It appears that lubricants containing these acids are most effective when the metallic surfaces are reactive and form superficial layers of soaps. Zinc and cadmium are such metals, and figures are given for coefficients of friction found for them under various conditions. —ZDA.

Action of Aluminum, Aluminum Alloys, and Stainless Steel on the Vitamin C Content in Milk. G. Reif. *Gesundh.-Ing.* (Germany), **69,** 325-327 (1948). *Chem. Absts.,* **43,** No. 9, 3533 (1949)—ALL.

Fungicides in Ammunition Materials. D. T. Lewis. Ministry of Supply, CRDD Report No. 103/R/47; *Prev. Det. Abs.,* **5,** F 23-4 (1948).

A study was made to determine which fungicide could be incorporated in compounds used near and or in contact with propellant or explosive fillings of ammunition; the corrosive effects of fungicides was also investigated.—RPI.

Versatility in Fatty Acids. R. Williams, Jr. *Chem. Eng.,* **56,** No. 7, 92-94; Flowsheet 128-132 (1949) July.

New General Mills plant in Kankakee, Ill. combines hydrogenation and esterification units with hydrolysis equipment. Hydrolysis tower is lined with Inconel to minimize corrosion by fatty acids. Continuous evaporators are made of copper for heat-transfer purposes since materials handled are not corrosive. Twitchell hydrolysis units are lined with Monel for corrosion resistance. Distillation trains are made of stainless steel. Reactor in hydrogenation unit consists of a stainless steel tank which has steam coils and an agitator. In esterification unit, stainless steel kettles are used. To produce solid products there is a stainless steel single roll flaker. —INCO.

The Effect of Acid Foods on Aluminum Cooking Utensils. C. F. Poe and J. M. Leberman. *Food Technology,* **3,** 71-74 (1949) Feb.—ALL.

Aluminum. E. D. Verink, Jr. *Chem. Eng.,* **56,** No. 6, 243-244 (1949) June.

One of the important applications of aluminum chemical equipment has been its use for condensing, storing, conveying, and handling of saturated organic mono-basic acids. Aluminum is used, not only for these acids, but for their derivatives and for fats. In some cases, satisfactory service records of over 18 years are not unusual in all these services at temperatures as high as 450° F (232° C). It is especially suited for service with fats and oils 1) because it has no pro-oxidant effects on the materials handled, and 2) because color and quality may be maintained. At storage temperatures, no attack is observed from uncontaminated fatty acids from acetic acid on through the higher acids such as stearic and oleic. The presence of heavy metals and chlorides may stimulate attack under certain conditions. At boiling temperatures, uncontaminated fatty acids do not attack aluminum, provided at least the slightest trace of moisture is present at the metal surface. The alloys normally recommended for service with fats and fatty acids are: 2S, 3S, and 52S for vessels; 3S and 63S for piping; 3S and Alclad 3S for heat exchanger tubes; 3S, 52S and 61S for shipping containers; and for castings, 43, B214 and 356. —ALL.

• Water

The Electrochemical Behavior of Zinc and Steel in Aqueous Media. R. B. Hoxeng and C. F. Prutton. Thesis prepared from data obtained in a research project sponsored by Amer. Iron & Steel Inst., Apr. 13, 1949. 22 pp. and 21 graphs. Presented NACE Mtg., Apr., 1949, Cincinnati, Ohio. *Corrosion,* **5,** 330-338 (1949) Oct.

Laboratory data are presented confirming the fact that under certain conditions of electrolyte composition and temperature zinc may become cathodic to steel. A qualitative interpretation is presented for the observations that chloride and sulfate decreased, whereas nitrates and bicarbonates increased, the probability of reversal in zinc-steel couples. Although in certain solutions increasing the temperature increased the

Bring on chemicals with TEETH!

"Karbate" Impervious Graphite tube-bundle heat exchanger, floating-end diaphragm construction, used for partial concentration of H_2SO_4 contaminated with volatile organics. Contains 233 tubes, ⅞ in. dia. by 9 feet long. Tube sheets are 28¾ in. dia. by 6¼ in. thick.

"KARBATE" Impervious Graphite Heat Exchangers ARE READY!

"Karbate" Impervious Graphite Heat Exchangers handle an extremely wide range of corrosive fluids. They are both acid-resistant and alkali-resistant. Their thermal conductivity is higher than that of most commonly used metals. They are light in weight, immune to thermal shock, will not contaminate the solution, and are amply strong and vibration resistant. "Karbate" heat-exchanger types include: tube-bundle, cascade, plate, bayonet, and concentric in standard and special sizes.

Other "Karbate" equipment includes: pipes and fittings, valves, pumps, tanks. For more details write to National Carbon Company, Inc., Dept. CO.

The term "Karbate" is a registered trade-mark of

NATIONAL CARBON COMPANY, INC.

Unit of Union Carbide and Carbon Corporation

30 East 42nd Street, New York 17, N.Y.

Division Sales Offices: Atlanta, Chicago, Dallas, Kansas City, New York, Pittsburgh, San Francisco

Foreign Department: New York, U.S.A.

These products sold in Canada by Canadian National Carbon Co. Ltd., Toronto 4.

probability of reversal, such reversals appear to depend more on electrolyte composition than on temperature. Research is being continued with particular attention to the effect of long exposure time and of the complex conditions encountered in natural waters.—ZDA.

Scale and Corrosion in Water Cooled Bakery Equipment. HERBERT M. ORRELL. *Baker's Digest,* **21,** 13-5 (1947) Feb.

A review.—RA.

Anti-Corrosion Measures Necessary in Air Conditioning Systems. J. I. MONTEL. *Refrig. Eng.,* **57,** 346-7, 384 (1949) Apr.

Tests made on various types of open recirculating water systems to study their corrosive action on iron showed that untreated recirculating cooling tower water was more corrosive than tap water of a distribution piping system, and that both resulted in more serious corrosion than that caused by normal atmospheric weathering. Spray water was more corrosive than pan water, due to constant replenishment of corrosive gases in sprayed water. Chemical treatment of the water was much more effective when automatic and continuous than when intermittent. The criterion of corrosiveness in these tests was the weight loss of mild steel strips suspended in the water.

Effect of Colloids on Corrosion in Hot Water and Heating Installations (Iron). W. MACHU. (In German.) *Archiv Metallkunde,* **3,** No. 2, 71-76 (1949) Feb.

Tests were carried out on the effect of water-glass, gelatin, agar-agar, starch, hay extract and tannin on the corrosion of soft iron at 60° in distilled water and conductivity water.—BNF.

Radiator Cleaners. M. A. LESSER. *Soap & Sanitary Chemicals,* **25,** No. 5, 40-43 (1949) May.

Corrosion of the automobile cooling system is discussed, and compositions of various corrosion inhibitors are given.—INCO.

Effect of Various Aqueous Solutions Upon the Reactions at Pure Iron Anodes and Cathodes. Part I. W. W. KITTELBERGER AND A. C. ELM. *Corrosion,* **5,** 101-112 (1949) Apr.

Briefly reviews theoretical principles and presents results of extensive experimental investigation of the above for the purpose of developing a method which would not only indicate when a metal is passive, but would also afford a means of measuring the "inhibitive power" of an environment. A method of this sort also should be applicable to measurement of the "corrosiveness" of non-inhibitive solutions. Procedure and equipment are described. Numerous graphs and tables. (To be concluded.)—BLR.

Water Works Maintenance. G. H. Dann, Philadelphia Suburban Water Co. *Iron & Steel Eng.,* **26,** No. 7, 51-56; Disc. 57-58 (1949) July.

It is not only possible to locate underground pipe lines without uncovering them, it is also possible to locate details of the line, and what may be more important, leaks. Discussion includes leak surveys, pipe location, loss of head tests, cleaning and coating pipe, pipe sizing, leak repairing, standpipe painting, and electrolysis and corrosion.—INCO.

Corrosion of Iron and Steel by Industrial Waters and Its Prevention. Iron & Steel Inst. Special Report No. 41, March, 1949.

Discussion of metallic corrosion, causes of corrosion, corrosion under industrial conditions and the prevention of corrosion. Iron and Steel are specifically mentioned. The book includes the investigation of corrosion problems.—INCO.

Problems in the Treatment of Cooling Water in Industrial Plants. L. D. Betz and J. J. Maquire, W. H. & L. D. Betz. Paper before Ill. Inst. Tech., 11th Ann. Midwest Power Conf., Chicago, Apr. 18-20, 1949. *Blast Furnace & Steel Plant,* **37,** No. 8, 972-976 (1949) Aug.

Corrosion and slime of once-through and open recirculating systems of cooling are discussed including cause of corrosion and means of prevention.—INCO.

Preventing Salt-Water Corrosion. T. A. Dickinson. *Org. Fin.,* **9,** No. 11, 9-11 (1948); *Chem. Abs.,* **43,** No. 4, 1578 (1949).

A general article on corrosion-preventing org. coatings.—RPI.

Marine Fouling and Boring Organisms —With Some Material on Corrosion. J. L. Baughman, Texas Game, Fish & Oyster Commission. Paper before NACE, Houston, Sept. 9, 1947. *Corrosion,* **5,** No. 4, 113-119 (1949) Apr.

Description of various groups of fouling organisms includes Chthamalus Stellatus, one of the barnacles, Tubularia, one of thehydroids, bryozoans, mollusks, serpulids, tunicates, and plants. Article covers topics of factors controlling fouling, effect on seacoast industries, blocking of screens by shells, sheathing to baffle teredos, poisonous paints, significance of leaching rate, borers, recurrence, and use of creosote. Diagrams are included. 27 ref.—INCO.

The Practical Problems of Corrosion—Part XII—The Influence of Corrosion on the Thermal Deposition of Calcium Carbonate. J. N. WANKLYN AND U. R. EVANS. *J. Soc. Chem. Ind.,* **68,** No. 6, 171-173 (1949) June.

Steel specimens partly immersed in calcium bicarbonate solution develop a white band of calcium carbonate, the cathodic product, along the water-line. When subsequently the surface is more deeply immersed in fresh bicarbonate solution, and heat conveyed to liquid through steel, distribution of calcium carbonate thrown out by thermal decomposition is almost unrelated to that of calcium carbonate produced in previous corrosion stage. Under experimental conditions, corrosion product contained both calcite and aragonite, and thermal deposit only argonite.—INCO.

Combat Corrosion, Scale, Slime in Air Conditioning Units. WILLIAM A. TANZOLA, Assistant Director Technical Division, W. H. and L. D. Betz Co. *Industry & Power,* **56,** No. 5, 99 (1949) May; Ibid No. 6, 97 (1949) June.

The first of this series of three articles describes and illustrates typical types of air conditioning systems and their water circuits, which include chilled water, spray water, and condenser water. Scale, corrosion, and slime occurrence are discussed with respect to equipment arrangement, type of operation, and the particular water circuit involved.

In the second article, adjusting pH of the water to 6.5 or above and addition of chemical inhibitors are given as means of preventing corrosion in the system. Scale formation is prevented by adjustment of water balances in keeping with Langelier's equation, and/or addition of surface-active chemicals such as special types of phosphates and organic materials. Control of slime growths with chlorine and other chemicals is discussed. Careful study before selection and application of chemicals is essential.—NALCO.

Aqueous Corrosion of Iron and Steel. F. N. SPELLER. *Metaux et Corrosion; Chim. Peint.,* **12,** No. 3, 91 (1949).

A resume of views on modern (and desirable) painting practice and surface pre-treatment for (generally) sub-aqueous exposure. Favorable mention is made of phenolic resins, chlorinated rubber, zinc, zinc oxide and Cr_2O_3 as constituents of satisfactory paint systems. 21 references.—RPI.

Investigations on the Electrical Treatment of Water. G. SEELMEYER. *Arch. Metallkunde,* **1,** Nos. 11/12, 475-480 (1947).

A description is given of experiments on electrical methods for softening water in order to prevent scale formation and corrosion. A max. softening effect was obtained by a combination of electromagnetic field and ultra-short-wave radiation. It is concluded that technical application of the methods would probably lead to extensive economics in materials and man-power.—MA.

Preventing Corrosion in Air-Conditioning System. W. J. RYAN, Water Service Labs. *Power,* **93,** No. 7, 84-85 (1949) July.

Discussion of factors involved and steps to control corrosion includes raw water, corrective measures, brine treatment, and scale prevention. Once the required chemical make-up of circulating solution is known, it should be made non-corrosive and held there.—INCO.

Relation of Water Supply to Chemical Plant Location. S. T. POWELL AND L. G. VON LOSSBERG. *Chem. Eng. Progress,* **45,** No. 5, 289-300 (1949) May.

Deals with selection and development of water as it influences industry, particularly the chemical industry. Controlled calcium carbonate scale, chromate treatment, and deaeration are compared as methods of preventing corrosion in cooling water systems. Photographs of specimens are included.—INCO.

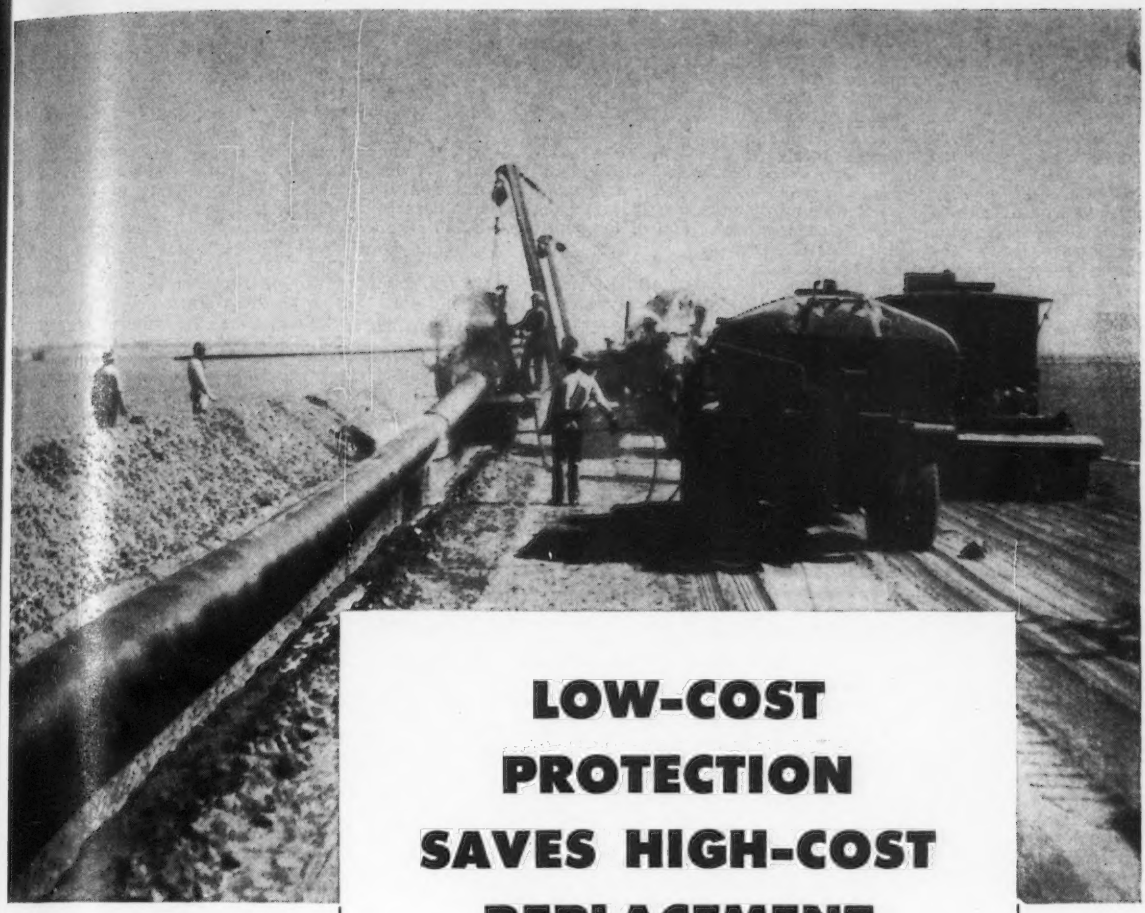
Calgon — A Chemical Development from a Nonchemical Background. E. P. PARTRIDGE, Hall Lab., Inc., AND C. R. TEXTER, Calgon, Inc. Paper before Commercial Chem. Development Assn., Mellon Inst. Oct. 5, 1948; *Chem. Eng. News,* **27,** No. 12, 840-43 (1949) Mar. 21.

Calgon, which reduces corrosion rate in steel pipe and equipment and prevents formation of lime scale, has been adopted by over 600 cities and towns for the treatment of municipal water supply. Photograph illustrates Calgon threshold treatment for corrosion control.

4.6, 5.8, 8.4

New Chemical Treatment of Flood Water for Bacteria and Corrosion Control. J. N. Breston, Penn. Grade Crude Oil Assn. Paper before API, Eastern Dis. Comm., Pittsburgh. *Oil Gas J.,* **48,** No. 16, 96-100+ (1949) Aug. 25.

Alkyl and argyl high molecular weight amine salts and certain condensed ethyl-



LOW-COST PROTECTION SAVES HIGH-COST REPLACEMENT

WHEN a steel pipe line, thousands of miles long, goes into the ground, it must have *permanent* protection against corrosion. Replacement is a costly operation.

For this permanent protection, corrosion engineers specify Koppers Bitumastic® Enamels—the protective coatings that offer you proved records of 30 to 40 years' service under severe corrosive conditions.

Koppers Bitumastic Enamels are processed from coal-tar pitch, a substance that has battled corrosion successfully for nearly a century. They are water-proof . . . inert to corrosive soil chemicals . . . do not deteriorate with age . . . and have high dielectric strength.

Discuss the low cost, lasting protection of Koppers Bitumastic Enamels with our sales engineers today. Koppers offers you prompt delivery from four strategically located plants and three warehouses.

KOPPERS BITUMASTIC ENAMELS
REG. U.S. PAT. OFF.

KOPPERS COMPANY, INC., Tar Products Division, Dept. 404T, Pittsburgh 19, Pa.

ene oxide-amine compounds have considerable acid corrosion-inhibiting properties as well as being effective bactericides for killing aerobic and anaerobic bacteria common to oil-field waters. Effectiveness of these compounds at extreme dilutions makes them potential bactericide-corrosion inhibitors for treatment of oil-field flood waters. They are most effective in air-free waters but may still be effective in certain O_2 containing waters. They also make promising water treating agents where flooding must be done with brine. Since these bactericide-corrosion inhibitor compounds have surface active properties, they should be valuable in cleaning out intake wells and increasing permeability of sand to water. —INCO.

4.6, 3.4, 7.6, 5.7, 1.7

Corrosion of Iron and Steel by Industrial Waters and Its Prevention. BISRA. Industrial Waters (Corrosion) Sub-Committee. Iron and Steel Inst. March (1949) Spec. Rep. No. 41.

The report begins with an analysis of the causes of corrosion and emphasizes that it is those causes associated with the water which exert most influence, whilst factors inherent in the iron and steel themselves have least effect. Other external factors such as temperature, rate of flow, nature of the corrosion products and stray eelctric currents are also considered. The next section of the report deals with the type of corrosion that occurs under specific industrial conditions, as in various types of marine and land boilers, refrigerating systems, etc. The report then outlines methods for controlling the composition of the water by removing dissolved gases, maintaining alkalinity, adding the correct amount of sodium sulphate to overcome caustic cracking, by water softening and the use of inhibitors. In discussing the various types of protective coating which may be applied to iron and steel surfaces, the committee does not suggest that any one type is superior to the others, provided the coating is continuous. Finally, a brief outline of procedure to be followed in the investigation of corrosion problems is given. There are 104 references.—ZDA.

4.6, 1.7

Corrosion of Iron and Steel by Industrial Waters and Its Prevention. BISRA. Iron Steel Inst. Special Report No. 41, Mar., 1949, 56 pp. Price 5s.

This brochure was prepared by a subcommittee on which the BNFMRA was represented. There are sections on metallic corrosion, causes, industrial corrosion, prevention, and methods of investigation, with a select bibliography (1927 to date) of 98 references.—BNF.

4.6, 6.2, 7.4, 3.2, 8.4

Corrosion of Non-Ferrous Tubes by Cooling Water in Refinery Heat Exchangers. A. G. Ellison, *Brit. Petr. Equip. News*, **1**, No. 1, 27 (1948).

Dezincification and season cracking are uncommon in good-quality brass tubes. Corrosion- erosion may be prevented by using such alloys as 76/22/2 aluminum-brass and 70/30 copper nickel. Care should be exercised to prevent gas entanglement in the cooling water, to stream line the entry of water into the heat-exchanger tubes with minimum turbulence in the water box, and to prevent entry of solid bodies liable to get lodged in the tubes. No alloy is wholly resistant to deposit attack and oxide pitting, but much depends on the surface finish of the tubes used.—IP.

4.6, 3.4, 4.3, 3.5

Variation in the Corrosivity of Waters. L. W. Haase. (In German.) *Archiv. Metallkunde*, **3**, No. 3, 114-117 (1949) Mar.

Relation between CO_2-content and corrosivity of waters towards ferrous and non-ferrous metals; formation of protective layers; effect of hardness of water and of temperature.—BNF.

4.6, 7.6, 8.4

Gasoline Plant Water Treatment. J. C. Hutcheson, Shell Oil Co. Paper before Natural Gasoline Assn. of Am., Regional Mtg., Amarillo, Dec. 12, 1947, with disc. by J. S. Conners (Phillips Petrol. Co.). *Petro. Proc.*, **3**, No. 3, 227-228+ (1948) Mar.

Practical information on methods for boiler feed water treatment from natural gasoline plant operator's standpoint. Three methods covered are lime-soda softening, Zeolite softening, and internal softening. Advantages and disadvantages of each are enumerated.—INCO.

4.6, 7.6

Canada's Largest Steam Plant Reports on Five Years' Feedwater Experience. J. E. Lewis, Polymer Corp. *Power*, **93**, No. 8, 108-111 (1949) Aug.

Feed treating conditions water for five high-pressure boilers using 65-80% make-up. They need cleaning only once in ten months. Discussion includes plant operations, softener operations, softened water analysis, deaerator operation, boiler water analysis, cleaning boilers, conductivity recorder, and chemical tanks. A 1,000,000 lb. per hour feed pump, opened after 5 years, showed no signs of internal scale or corrosion.—INCO.

4.6, 1.7, 4.3, 3.2

Corrosion of Water Fittings. *Plumber*, **71**, No. 844, 40-43 (1949).

A summary of the Report of the Water Pollution Research Board for 1947, which refers to investigations made into the effect of chlorine on the corrosion of metals by water. The dezincification of α/β brass is described.—MA.

4.6, 7.6, 5.7, 4.4

European Experiences with Feedwater Treatments. A. G. Splittgerber. Paper before Steam Users' Assn., Feb., 1949. *Combustion*, **21**, No. 2, 48-49 (1949) Aug.

Discussion includes reduction of silicic acid and carbonic acid in feedwater, reduction of O_2 content, anti-corrosion in Benson boilers, caustic brittleness, H_2S corrosion in nickel alloys, anti-corrosion in condensate systems, chlorination of cooling waters, high pressure boiler feedwater, and methods of analysis.—INCO.

4.6, 7.6, 5.7

Boiler Water Treatment. R. C. Ulmer, E. F. Drew & Co. *Combustion*, **19**, No. 10, 38 (1948) Apr.

Proper diagnosis important before giving consideration to how a feedwater problem should be solved. Standardization in terminology and in methods of sampling and reporting results would lead to better understanding. Most ordinary scale and deposits can be eliminated by maintaining proper alkalinities and/or phosphates.—INCO.

4.6, 2.3, 6.1, 3.2

Complete Corrosion Tests on Iron and Steel Pipes. G. A. Ellinger, L. J. Waldron and S. B. Marzolf. NBS., *Ind. & Power*, **57**, No. 1, 91-2 (1949) July.

Results are presented from laboratory tests on pipe corrosion, made over a ten-year period, and just completed by the NBS. Tap water of known analysis was circulated at constant velocity through eight vertical columns each containing 14 specimens of various pipe materials. Length of exposure time varied considerably from several months to the duration of the experiment. Corrosion was evaluated by loss of weight and depths of pits. Corrosion of interior pipe surfaces started with formation of small localized mounds of rust, the number and size increasing with time. Wrought iron (hand puddled), open hearth steel, copper bearing steel, ingot iron, copper-molybdenum ingot iron and nickel-bearing wrought iron exhibited lowest corrosion losses; wrought iron (aston process), sand cast iron, and centrifugal cast iron exhibited somewhat higher losses; highest losses occurred in copper-chromium-phosphorus-silicon steel. Similar data are graphed for averaged pit depths. Shallowest pits occurred in centrifugally cast iron. There was no great difference in corrosion rates of most wrought materials when measured by loss of weight or depth of pitting.

4.6, 7.6, 8.4

Surface Water Made Fit for Boilers. A. L. Wilson, Esso Standard Oil Co. *Power*, **92**, No. 5, 83 (1948) May.

Supplying all water needs, refinery draws water from surface and ground wash and prepares it for corrosion-free service, not by filtration, but by using retaining basins and coagulation. Deaerating tank heaters stand between sedimentation tanks and boiler feed pumps. Plant used steel economizers and has yet to lose a tube to internal corrosion. Flow diagram shows preparation stages to fit water for refinery and boiler.—INCO.

PREVENTIVE MEASURES

• Cathodic Protection

5.2

Physical and Chemical Characteristics of Zinc Anodes. E. A. Anderson. Cathodic Protection Symposium (Electrochemical Society and National Association of Corrosion Engineers), 1947 (published 1949), pp. 97-100.

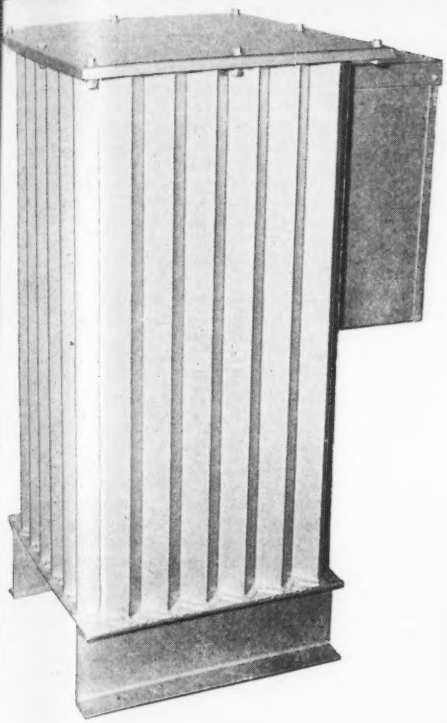
Discusses briefly the corrosion of zinc in the atmosphere, in aqueous solutions and in the soil.—BNF.

5.2

Use of Aluminum and Magnesium as Anode Material for Cathodic Protection Against Corrosion. N. B. Bagger. *Mat and Method.*, **30**, No. 1, 47-49 (1949) July.

Aluminum is a good anodic material for cathodic protection, but where an external source of d.c. power is applied, anodes of aluminum-copper alloys such as 17S-T and 24S-T are superior to either commercially pure aluminum or the aluminum-zinc alloys. Aluminum-copper alloys have a low electrochemical equivalent, and with 100% anode current efficiency, a smaller weight of aluminum will be dissolved per amp.-hr. The corrosion products of aluminum adhere to the anodes after forming, thus

ANNOUNCING A REVOLUTIONARY NEW CATHODIC PROTECTION UNIT!



The new-style Westinghouse oil-immersed selenium rectifier—a 24 volt, 90 ampere unit just 43 inches high overall—36 gallons of oil suffice where 150 gallons were required in identical units of previous design.

SEE IT IN OUR BOOTH NO. 90 APRIL 18-19-20 AT THE P.I.E.A. CONVENTION IN HOUSTON

Brance-Krachy proudly presents a completely new line of Westinghouse selenium, oil-immersed rectifiers engineered and designed to give you these advantages:

1. 75% less cooling oil required.
2. Equipped with new Westinghouse high-voltage selenium plates for long life and trouble-free performance.
3. Heater type overload protection integral with the AC starter.
4. Improved appearance.

BRANCE-KRACHY *Cathodic Protection* **RECTIFIERS**

LEADERS IN CATHODIC PROTECTION EQUIPMENT

FOR OVER 20 YEARS

Since the early days of wind-driven generators to the modern air-cooled and oil-immersed rectifiers, Brance-Krachy has been the leader in engineering the equipment best suited for cathodic protection installations.

ADD VALUABLE YEARS OF LIFE AND SERVICE WITH B-K PACKAGED PROTECTION UNITS

Brance-Krachy complete package-type protection units include either copper oxide or selenium, air-cooled or oil-immersed rectifiers, underground "trench wire," graphite and carbon anodes and coke breeze backfill. Complete cathodic protection installations sent to your job as a unit. ALCOA magnesium anodes and M. C. MILLER'S MULTI-COMBINATION METERS in stock. We have all accessories for installing any type cathodic protection installation.

COMPLETE CATHODIC PROTECTION EQUIPMENT — BK

Brance-Krachy Co. INC.

4411 NAVIGATION • P.O. Box 1724 • HOUSTON

For Full Information Write—Wire or Teletype (HO-561)

preventing discoloration and contamination of the electrolyte, which is particularly important when the anodes are installed inside water storage tanks. Because aluminum has a uniform dissolving rate, no deep pits develop on the surface of the anode, and no film of high resistance forms to limit current flow. The light weight of aluminum anodes is also an advantageous factor in reducing costs incidental to the installation of the wasters.

Magnesium has an electrical output of 1000 amp.-hr. per lb. and shows little tendency to polarize. Commercially pure magnesium has a 0.1-v higher solution potential than its commonly-used alloys but it is more subject to lower current efficiencies and shorter life. In alloying, some of the voltage is sacrificed but this loss is more than compensated by the increased efficiency and prolonged anode life. A magnesium alloy of high current efficiency has been developed for anode use with the following composition limits: 5.6 to 6.7 aluminum, 0.18 manganese, 2.5 to 3.5 zinc, 0.3 silicon, 0.05 copper, 0.003 nickel, 0.003 iron, 0.3% other impurities, and the balance magnesium. An important use of magnesium anode is in domestic hot water tanks and similar steel structures, where the magnesium anode is usually installed in as nearly central location in the tank as possible in order to obtain equitable distribution of current.—ALL.

5.2

The Technique of Cathodic Protection. R. de Brouwer. *Metaux et Corrosion,* **23,** Nos. 271-272, 57-70 (1948) Mar.-Apr.

The subject is discussed under the headings, polarized drainage, drawing off of current, classical cathodic protection, and sacrificial anodes.—ALL.

5.2, 8.4

Cathodic Protection Within an Oil Refinery. D. Holsteyn, Shell Oil Co. Preprint, API., 14th Mid-Year Meet., Refg. Div., Houston (4/4-7/49) 10 pp.

A systematically developed cathodic protection program on network of bare pipe lines and storage tank bottoms of an oil refinery has resulted in an average reduction in maintenance cost of 30 to 35%, based on 1940-41 maintenance expenditures of 100%. Multiple anodes are used for a desired current distribution in preference to the use of insulating flanges and resistors in the electrical circuit. Curves pertaining to the behavior of a ground rod and a series of ground rods, which discharged current to the earth, are shown, along with a diagram of a typical cathodic protection system. The training of personnel on the theories of soil corrosion and cathodic protection is also discussed.

• Metallic Coatings

5.3, 3.5

Protective Coatings for Steel—Cementation. Processes Reference Book Sheet. J. L. Bleisweis. *Am. Machinist,* **93,** No. 18, 143 (1949) Sept. 8.

Discussion of calorizing and Sherardizing gives data on nature of coatings, treatment procedure, notes and comments. Calorizing is a method of producing an aluminum-iron alloy coating steel to protect the steel from oxidation and scaling at elevated temperatures. Sherardizing is a method of producing a coating of zinc on steels by heating of steel parts in an atmosphere of zinc dust.—INCO.

5.3, 3.5, 4.2

Bolted Aluminum-to-Copper Connections. W. F. Bonwitt. *Elec. Eng.,* **67,** 1190 (1948) Dec.

Results are presented of extensive tests in which various electroplates and other metallic coatings were applied to the copper members. Different compounds were also used between the contact surfaces, and tests were made using only the bare metals. Twenty-one combinations were evaluated both at elevated temperatures and in a corrosive atmosphere. The main criterion of performance was electrical resistance. Results are summarized, showing completely satisfactory performance when the proper treatment had been applied.—MR.

5.3, 5.9, 8.1

The Electrodeposition and Properties of Tin-Zinc Alloys. J. W. Cuthbertson and R. M. Angels, Tin Research Institute, Greenford, Eng. *J. Electrochem. Soc.,* **94,** No. 2, 73-98 (1948) Aug.

Tin and zinc can be codeposited in all proportions from still solutions containing sodium stannate, sodium hydroxide, sodium zinc cyanide, and free sodium cynanide at 65° C and at a cathode current density of 10-30 amp per sq. ft. using anodes of the same composition as the alloy to be deposited. The composition of the deposit is adjusted by varying the amounts of sodium zinc cyanide, total cyanide, and sodium hydroxide. The tin content of the solution is maintained at 30 g. per liter and the free cyanide at 17.5-20 g. per liter.

A plate, at least 0.0003 in. thick, of about 78% tin-22% zinc is easy to solder and gives greater corrosion protection to steel than does a cadmium or zinc plate of equal thickness. The recommended thickness for most applications is 0.0005 in., but may be increased to 0.001 in. for use under severe conditions. Both corrosion resistance and solderability decrease slightly, but steadily, as the tin content is reduced under 78%; but corrosion resistance is not seriously impaired until the tin falls below 50%. Moreover, the operation of a low-tin bath is difficult and less economical than hot dipping.

Tin-zinc plate is very ductile and, being harder than tin, may be readily polished.

Passivation of tin-zinc plate in hot 2% chromic acid solution increases its corrosion resistance and reduces any tendency toward fingermarking. Thickness and depth of coloration of the passive film increase with the temperature and time of immersion; 15 sec. at 50° C gives a thin, colorless film which does not impair the solderability of the plate, whereas 30 sec. at 80° C produces a yellow or brown film.

The 78% tin alloy is used mainly in electrical industries as an alternative for cadmium to protect radio chassis, loudspeaker frames, valve screens, and other components. It is also being considered for protecting ship's fittings and other engineering applications. The 50% composition is used for general outdoor protection of structural steel.—PDA.

5.3

Aluminum-Protected Steel. R. Groves. *Prac. Eng.,* **17,** No. 418, 94-95 (1948).

Manufacture and uses of aluminum-clad steel are given.—MA.

5.3, 2.3, 3.2

Metallic Films versus Corrosion. I, II, III, IV, V, VI, VII. L. Sanderson. *Prac. Eng.,* **16,** No. 407, 444-445; No. 408, 466-467; No. 409, 488-489; No. 410, 512-513; No. 411, 536-537; No. 412, 567-568 (1947); **16,** No. 413, Ibid, 582-583 (1948).

A general description of the various types of corrosion is given and the electrochemical theory introduced. Some oxide films are described. (II.) Preliminary treatments, such as degreasing and pickling, are reviewed, and methods of coating, such as cladding, hot-dipping, etc., discussed. (III.) Terneplate and sprayed coatings are considered, as well as the processes of Sherardizing, calorizing, and chromizing. (IV.) Electrodeposition of various coatings and cathode sputtering are covered. (V.) Several methods of measuring the thickness of metallic coatings are presented. (VI.) Other tests of coatings, and corrosion testing of coated materials are surveyed, and notes given on zinc coatings. (VII.) The properties and the techniques of deposition of nickel, chromium, copper, tin and rare metal coatings, and Corronizing, are dealt with.—MA.

• Packaging

Sodium Benzoate as Inhibitor. *Chem. Trade J.,* **124,** 242 (1949) Mar. 4.

Sodium benzoate has been found effective as a corrosion inhibitor in automobile cooling systems when added in small proportions to solutions of glycerine or glycol. The discovery has been applied to wrapping materials impregnated with sodium benzoate. Steel specimens in these wraps remain bright in conditions of high humidity, even if the wrapping becomes soaked with precipitated moisture. Sodium benzoate is a safe inhibitor in that if the concentration falls below the inhibiting percentage it does not induce corrosion and localized pitting.

• Inhibitors

Use of Inhibitors for Controlling Metal Corrosion — I-V. G. T. Colegate. *Metallurgia,* **39,** No. 229, 18-20 (1948); Nov.; Ibid., No. 231, 149-151; No. 232, 219-221; No. 233, 263-265; No. 234, 316-318 (1949) Jan., Feb., Mar., Apr.

Discussion of general principles of corrosion includes types of corrosion and classification of various inhibitors in use. Use of inhibitors for preventing galvanic action between dissimilar metals in contact or in presence of an aqueous medium is discussed. Chromates, dichromates, silicates, phosphates, sodium nitrite and vapor phase inhibitors are considered. Use of more than one inhibitor and inhibitors used in acid pickling of steel are described. Inhibitors for use with aluminum, magnesium and steel are discussed. 30 references.—INCO.

The Protection of Copper with Anthraquinone Against Corrosion by Solutions of Sulfur. L. G. Gindin and I. Kh. Sit's. *Doklady Akad. Nauk,* **63,** No. 6, 685-8 (1948).

A copper plate immersed in a benzine solution of elemental sulfur shows traces of corrosion within 30-60 sec. but will remain bright for 200 or more days when 9,10-anthraquinone has been added to the solution. However, the inhibiting effect is virtually nil when using freshly polished plates. Apparently the thin

copper oxide film formed on the plate over a period of a few days in open air retards the attack by sulfur for a limited time until the anthraquinone is adsorbed on the surface and takes over the protection. Hardly any retarding effect is noticeable in the absence of anthraquinone.

Control of Steam Condensate Corrosion by New Polar Film Treatment Using Long Chain Amines. H. L. KAHLER AND J. K. BROWN. ACS 115th Meet., San Francisco. (3/27-4/1/49); Abstr. of Papers: 3-4R.

Long-chain amines above decylamine and preferably close to octadecylamine possess the property of laying a film on metals which protected them from the corrosive forces of the acidic gases present in the condensate. These amines were used in minute amounts, as neutralization was not necessary, and only enough amine was required to provide a protective film. In comparative tests on a condensate analyzing 80 ppm., carbon dioxide, zero oxygen at pH 5.0, octadecylamine at 1, 4, 20, and 123 ppm., morpholine at 154 ppm., and cyclohexylamine at 154 ppm. gave, respectively, 61, 79, 93, 91, 75, and 66% protection to steel. This filming amine, octadecylamine, thus saved as much steel at one and four ppm. as cyclohexylamine and morpholine did at 154 ppm. Use of cyclohexylamine and morpholine at these concentrations neutralized the condensate to pH 6.5 to 6.7, while the octadecylamine did not affect the pH. Octadecylamine was also able to withstand to a better degree the presence of large concentrations of oxygen while giving satisfactory steel protection. Hexadecyl, tetradecyl, and dodecyl amines gave protection in decreasing order as the chain grew shorter. The amines are covered by U.S. Patent 2, 460, 259.

Corrosion Problem of Anti-Freeze. *Light Metals*, **12**, No. 134, 165-168 (1949) Mar.

Use of guanidine and guanidine carbonate as inhibitors for cooling fluids containing ethylene glycol; and sodium benzonate for water cooling systems.—BNF.

The Corrosion of Metals. W. H. J. VERNON. Paper before Royal Soc. of Arts, Feb. 21/28, 1949. *Chem. and Ind.*, No. 11, 168 (1949) Mar. 12.

Sodium benzoate, an effective antifreeze agent, also possesses the outstanding property, when added in small proportions to solutions of glycerine or glycol, of inhibiting the corrosion of metals in the cooling system of automobile engines. This discovery has been applied to wrapping materials which do not merely exclude humid or polluted atmospheres, but have the more positive effect of preventing attack on the underlying metal if the wrapping is defective. This has been achieved by impregnating the wrapping material with sodium benzoate.—INCO.

Corrosion Inhibitor for Carbon Tetrachloride. RAYMOND WILLIAMS, U. S. Signal Laboratory, Fort Monmouth, N. J. (Technical Memorandum No. M-1156) (1948) Oct.

A 2% solution of mesityl oxide or a 0.001% solution of diphenylamine inhibits the corrosion of tin cans by carbon tetrachloride. The diphenylamine seems to cause a very light film of corrosion products over the entire steel surface whether immersed or unimmersed. Neither F-X fluid nor phenoxypropylene oxide are adequate inhibitors for this specific purpose.

Since dry carbon tetrachloride is remarkably inert, corrosion is probably due to traces of water, which may cause the formation of hydrolytic products, such as hydrochloric and carbonic acids. When catalyzed by the presence of iron, the mesityl oxide probably combines with and thus removes the water or hydrochloric acid before it can attack the steel.

A total of 23 inhibitive compounds were tested on soft rolled, polished steel strips, rinsed, and immersed in untreated carbon tetrachloride.—PDA.

Polar-Type Rust Inhibitors. (1) Theory and Properties. H. R. BAKER AND W. A. ZISMAN. (2) Methods of Testing the Rust Inhibition Properties of Polar Compounds in Oils. H. R. BAKER, D. T. JONES AND W. A. ZISMAN. *Ind. Eng. Chem.*, **40**, No. 12, 2338-2347 (1948) Dec.; **41**, No. 1, 137-144 (1949) Jan.

1) analyzes inhibiting property and discusses relation of inhibition to molecular structure. 2) deals with the turbine oil rusting test, the static water drop corrosion test and tests carried out in the fog cabinet and the humidity cabinet. Solubility and colloidal stability are considered.—BNF.

• Surface Treatment

The Application of Phosphate Coatings to Wire, Tube and Deep Drawing. H. A. COLDEN AND S. J. SCOUSE. *Sheet Met. Ind.*, **26**, 123-134, 136 (1949) Jan.

Describes above process, properties of the coating, and applications for protection and as a lubricant for miscellaneous steel-working processes. Fourteen references.—BLR.

Pickling and the Removal of Oxide from Nickel and Nickel Alloys. W. F. BURCHFIELD. Metals Handbook (ASM) 1940-1041 (1948).

Ten pickle formulae are given, with an indication of the ones to use to remove light tarnish, reduced oxide, or heavy oxide from various nickel alloys.—MA.

Barrel Finishing of Metal Products. XXIV—Concluding the History of the Development of Barrel-Finishing Materials. H. LEROY BEAVER. *Prod. Fin.*, **12**, No. 11, 56-58+ (1948).

The development of burnishing material other than spherical in shape is reviewed.—MA.

Finishing Copper and Copper Alloys. ASM Sub-Committee on Finishing Copper Alloys. Metals Handbook (ASM), 888-895 (1948).

Describes methods of mechanical cleaning and surface conditioning, chemical and electro-chemical cleaning, pickling and bright dipping, surface preservation and decoration (by enamels or lacquers), and coloring and chemical dipping.—MA.

A High-Aluminum Zinc Alloy. E. GEBHARDT. *Z. Metallkunde*, **39**, 142-144 (1948).

Resistance to corrosion by loss in weight for periods up to 200 hours at 11° to 13° C of a wrought alloy containing 31.2% aluminum, 2.98% copper, 0.06% magnesium, 0.18% iron is given in 5-96% acetic acid, 1-95% sulfuric acid, 1-65% ntric acid and 1-37% hydrochloric acid. The order of resistance was CH_3COOH, H_2SO_4, HNO_3 and HCl. Maximum corrosion rates were at 25% in HCl at 30% in HNO_3, at 10% in H_2SO_4 and at 10% in CH_3COOH.—INCO.

Metal Finishing Process Information Sheets. Parts I and II—Aluminum. G. BLACK. *Prod. Eng.*, **19**, No. 11, 157-159 (1948) Nov.

Electrochemical processes described are chromic acid anodizing, Alumilite and Alzak; the non-electric processes are Alodizing, Bonderite 170, Alrok, Alumatreet and Alumox. Information given comprises method, application, procedure and characteristics. Compositions of process materials are not included.—BNF.

Barrel Finishing of Metal Products. XX—Continuing the Discussion of the Use of Pebble and Fractured Mineral Forms in Barrel-Finishing Procedure. XXI—The Application of Ceramic Barrels to the Finishing of Metal Products. XXII—A Further Discussion of the Use of Minerals in Barrel-Finishing Processes. XXIII—The Progressive Development of Steel Burnishing Materials. H. LEROY BEAVER. *Prod. Fin.*, **12**, No. 7, 58-60+; No. 8, 58+; No. 9, 78+; No. 10, 60-62+.

XX—Considers the advantages of irregularly-shaped barreling material over round forms for reaching into angles, grooves, etc., and goes on to refer to liners for barrels using pebbles, and to the barrel size necessary. XXI—It is pointed out that the use of ceramic barrels would overcome one of the serious disadvantages of wooden barrels, namely that of absorption of the barreling fluid by the wood, thus making it difficult to change from one type of solution to another without some degree of contamination, and also that it would overcome an objection to metal barrels, namely the risk of contamination of some of the solutions used by the metal of the barrel. B. advocates the use of roller-driven ceramic jar mills, similar to those used for pulverizing and mixing pigments, etc., for the barrel finishing of small metal parts. No experiments have been conducted on hexagonal or octagonal ceramic barrels. XII—A general discussion of the various types of mineral material that may be used in barrel finishing. XIII—A brief historical account.—MA.

Anodic Oxidation of Aluminum and Its Alloys. *Aluminium Development Association Information Bull.*, **14**, 61 p. (1948).

Deals with the following aspects of anodizing; general procedure; a comparison of the chromic, sulphuric, and oxalic acid processes, with brief descriptions of other proprietary processes; dyeing of the anodized film, including tables of suitable dyestuffs; characteristics of the film; and the electrolytic brightening of aluminum. Methods for anodizing-bath control; tests for porosity, continuity and sealing of the film; a selected bibliography of 40 references; and a list of 177 British patents up to March 1948, are given in Appendices I-VI.—MA.

Surface Preparation by Electropolishing. CHARLES L. FAUST. Pittsburgh Internat. Conf. on Surface Reactions (Proceedings), 187-195 (1948).

The mechanism of electropolishing is discussed, with reference to the forma-

tion during electropolishing of viscous liquid films saturated with the products of anodic dissolution and/or gaseous films. Chemical and physical properties of electropolished surfaces are described and it is shown how the nature of electrodeposits is affected by electropolishing the basis metal, as opposed to preparing its surface by other means. The usefulness of electropolishing for the surface preparation of specimens for corrosion tests is emphasized. Electropolishing is an empirical process since the solution and conditions required for a given purpose usually can be selected only by trial and error. No details of actual electropolishing baths are given in the paper, but 94 references to the literature are included.—MA.

Pickling vs. Grit Blastings for Cleaning. J. F. FARRELL. *Met. Fin.*, **47**, 69-75 (1949) Feb.

Discusses advantages and limitations of abrasive cleaning as compared to pickling. Describes equipment for the former, economic considerations, effect on finish, abrasives used, and typical applications. —BLR.

Finishes for Aluminum Alloys. JUNIUS D. EDWARDS. Metals Handbook (ASM), 789-791 (1948).

Procedures are described briefly for mechanical finishing (scratch-brushing, sand-blasting), cleaning and etching, anodic oxidation (in particular by the Alumilite process), electropolishing (by the Alzak process), electroplating, and painting.—MA.

Chemical Treatments Contribute to Quality (of Die-Castings). *Die-Castings*, 6, No. 12, 43-46 (1948).

Surface conversion coatings for aluminum and zinc die-castings are discussed. —MA.

Electroplating: Notes and Problems. R. Cruickshank Ltd., Birmingham, England. 94 pages, 1948. *Met. R.*, **21**, No. 12, 58 (1948) Dec.

Extensive notes are presented on all phases of the finishing of metals—cleaning and degreasing, barrel polishing and plating, bright dipping, metal coloring, polishing, anodizing and dyeing, and testing. It is essentially a note book and under each heading are given only the main features of each process.—ALL.

Continental Trends in Metal Finishing. W. F. COXON. Proc. Third Internat. Electrodeposition Conf., 91-93 (1947).

Impressions of German, Swiss, French, Dutch, and Swedish metal-finishing practice gained over the period Nov. 1945-Dec. 1946. Particular attention is paid to the anodizing and electropolishing of aluminum, and phosphating.—MA.

Shot Peening; A Survey of Modern Methods and Applications. G. T. COLEGATE. *Sheet Met. Ind.*, **26**, 141-148, 1-52, 371-381 (1949) Jan., Feb.

Includes discussion of the nature of fatigue failure of metals and of the mechanism of shot peening. Describes development of the process; the shot used; equipment; and procedures. Second installment describes factors affecting intensity of peening; effect of tempering after shot peening; measurement of peening intensity; interpretation of test results; peening methods and equipment; and miscellaneous applications to ferrous and nonferrous metals. Illustrated. Twenty references.—BLR.

MATERIALS OF CONSTRUCTION

• Ferrous Metals

Investment Casting. R. B. GORDON, Westinghouse Electric Corp. *Machine Design*, **21**, No. 3, 139-140 (1949) Mar.

Problems encountered in the production of a switchgear lever on a standard Westinghouse network breaker by the investment casting process are discussed. Initial samples were cast in 12 chromium stainless steel (Type 410) and had a hardness of about 35 Rockwell C. Shop tests proved the material was machineable and life tests indicated strength and wear resistance were adequate, so it was possible to eliminate the heat treating operation used previously. Improved corrosion resistance is listed among advantages resulting from the adoption of this casting method.—INCO.

6.1

Unappreciated Advantages of Modern Gray Iron. F. G. Sefing. *Mech. Eng.*, **70**, 667-670, 674 (1948) Aug. *Can, Metals, Met. Ind.*, **12**, No. 4, 16-19 (1949) Apr.

The outstanding properties of gray iron which are an improvement over those of steel are resistance to wear and galling, improved resistance to corrosion by water and by heat, less tendency toward warping under heating and cooling, increased capacity to dampen vibration, high notch fatigue, compression and torsional strength, to some extent increase electrical resistivity, and, finally, low cost of forming, and very good machinability. On the other hand, there are some properties which are definitely lowered by the presence of graphite, notably, a reduction in tensile strength, reduced stiffness or modulus of elasticity, and a low order to toughness. Comparisons between medium- and high-strength irons show that high-strength irons can be made to have about twice the toughness and greater stiffness, at the same time retaining good wear, machining and damping properties. With different types of gray irons, which can be specified suitably, a variety of resistance to metal-to-metal wear can be achieved. It is essential to note that those gray irons with the high-strength range and other properties attainable at extreme levels have alloy additions. This is not surprising, since it is well known how the extremes in combinations of properties are achieved in alloy steels, as compared with those attainable in plain steels. Similarly, the high mechanical properties of the better gray irons can be obtained with alloy additions and without the need of heat-treatment, whereas in steels the higher mechanical properties are associated with heat treatment. In general, the strength of gray iron, which commonly is of the order of 20,000 to 30,000 lb. sq. in. tensile strength can be increased to levels of from 40,000 to 70,000 to 90,000 lb. sq. in. tensile strength by the addition of from 1 to 4 percent of suitable alloying elements such as nickel, chromium, molybdenum, vanadium and copper. Marked improvement to corrosion resistance can be achieved with rather heavy alloy additions of from 20 to 35 percent nickel. This group of irons is as different from gray iron as the austenitic 18-8 stainless steel is from plain steels. Piston rings for enignes and pump pistons are most commonly made in gray iron because of the need for resistance to wear, corrosion and heat, and high vibration-damping capacity. Motor blocks and engine and pump cylinders require resistance to wear and corrosion and high damping capacity, together with a low cost of forming the metal to the desired shape. One of the outstanding examples of applying modern gray iron is in engine and compressor crankshafts. They are used in small compressors, automotive engines and in large Diesel engines such as submarine Diesels where the gray-iron crankshafts weigh up to 10,000 lbs. The use of gray iron in a crankshaft is for the high vibration-damping capacity, a high notch-fatigue strength of the metal, good wear properties on the bearings and the low cost of forming or founding and machining to the desired shape, as compared with forging and machining. For example, a forged-steel chankshaft weighed 18,000 lbs., and when ready for installation, 14,000 lbs. (4000 lbs. removed). The gray iron crankshaft for the same engine weighed 10,000 lbs. as cast, and 9200 lbs after machining.—TIME.

6.1

Structural High-Tensile (Low Alloy) Steel. O. A. Kerensky. (A condensation.) *Engineer*, **187**, 238-241 (1949) Mar. 5.

Discusses types of the above; methods of obtaining (cold working, heat treating and alloy additions); their welding, corrosion, allowable stresses, effect of fatigue and economics of use. Concludes that weight savings make wider use of such steels in structures highly desirable. 32 ref.—BLR.

6.1, 3.2, 5.3, 2.4, 7.1, 2.2

Changes Found on Run-in and Scuffed Surfaces of Steel, Chrome Plate and Cast Iron. J. N. Good and Douglas Godfrey. U. S. National Advisory Committee for Aeronautics. *Technical Note*, No. 1432, 22 (1947) Oct.

"Run-in" and scuffed SAE 4140 steel, chrome plate and cast iron surfaces were studied by means of X-ray and electron diffraction, micro hardness determinations and microscopic techniques. Portions of used aircraft engine cylinder barrels and piston rings were examined directly, whereas similar pieces of new parts were examined after rubbing under pressure in a reciprocating slider machine. Surface changes varied and could be classed as chemical reactions, hardening and crystallite-size alterations, all three being about equally important.

Chemical and physical changes on reciprocated specimens were superficial compared with those produced by engine tests, the depths of the changes varying from 10^{-4} to 10^{-3} in. for the engine-tested equipment and from 10^{-5} to 10^{-4} in. for the reciprocated surfaces. The compounds present on the former were present also on slider surfaces of the same material, but the compounds and phases were more easily identified on the latter.

SAE 4140 Steel, Reciprocating Slider

Surface Condition	Material Identified	Questionably Identified
Unrun	α-Fe	Fe_3O_4
Worn unscuffed	α-Fe	Fe_3O_4, Fe_2O_3
Scuff recovered	α-Fe, Fe_3O_4	Fe_3C, Fe_2O_3
Scuffed	α-Fe, Fe_3O_4, Fe_3C	Fe_2O_3

SAE 4140 Steel, Aircraft Engine Cylinder Barrel

Surface Condition	Material Identified	Questionably Identified
Worn unscuffed, superficial face	Graphite, Beilby Layer	Mixed oxides
Less than 0.001 in. below surface	α-Fe, Fe_3O_4, Fe_2O_3	

Chrome-Plated, Cast-Iron Rider

Surface Condition	Material Identified	Questionably Identified
Unrun	α-Fe	Fe_3C
Worn	α-Fe	Graphite
Scuffed	α-Fe	Graphite

As evident from the table, the principal chemical reactions were oxidation and carburization. The strength of the Fe_3O_4 diffraction pattern from scuff-recovered steel and the strong evidence of Fe_3C from scuffed steel indicate that the oxide can be associated with scuff resistance, and the carbide with scuff. Formation of the red Fe_2O_3, because of its softness and poor adherence, has always been associated with unfavorable results. The hardness of the chrome surface increased markedly for the burnished surface condition and corresponded with the formation of Cr_2O_3 and Cr_3C_2. Crystalline sizes were in order of 10^{-7} cm and varied with surface condition. The relations between crystallite size and hardness for steel, chrome and cast iron show complex variations.

The reciprocated specimens were prepared by placing beneath a loaded fixed rider and lubricating with Navy 1120 oil. Boundary lubrication is believed to exist at the ends of the stroke, hydrodynamic lubrication at the middle. The two mating surfaces were lapped with silicon carbide, cleaned with solvents, and mated by reciprocation under a constant load of 600 lb. sq. in. for 15 min. For scuffed specimens the rider was loaded in increments of 100 lbs. sq. in. every 5 min. until scuffing was observed. Scuffing, accompanied by rapid temperature rise, served as a criterion of surface failure: this occurred usually within 2-3 hr.

X-ray diffraction patterns were obtained with Kα radiation, the specimens being mounted as in a Debye-Scherrer powder camera. Calculations of crystallite size were made from lime broadening, using fine copper powder to determine the standard line breadth. Electron diffraction studies were made after each of five successive abrasions of the metal on OO emery paper under pure benzene. Hardness was measured with either Knoop or Vickers indenters.—PDA.

• Non-Ferrous Metals

Wiped Joints for Aluminum Sheathed Cables. *The Engineer,* **177,** No. 4853, 102-103 (1949) Jan. 28.

An important stage in the development of aluminum-sheathed cables by Johnson and Phillips, Ltd., Charlton, London, was reached when the company recently devised a simple technique for producing wiped joints. The wiping process consists of three distinct operations—cleaning, tinning and wiping. After removing all traces of grease or oil from the sheath, the surface oxide film is removed by scraping with a fine file or wire brush. The cleaned surface is heated by means of a blow-lamp to a temperature sufficient to melt the solder which is applied by rubbing the stick firmly and evenly over the heated surface. Tinning is completed by methodical application of a wire brush to the aluminum through the molten layer of tin to remove any remaining oxide and promote thorough amalgamation with the aluminum. No flux of any kind is used in the tinning process and the solder is an alloy consisting of 90 per cent tin and 10 per cent zinc. For the final operation of wiping the sleeve to the tinned sheath only standard quality plumber's metal is used. Normal lead wiping procedure is followed, but care must be taken to use only a trace of tallow and not to allow the tallow to touch the tinned aluminum. The wipe and adjacent two inches of cable sheath should be painted with bitumastic paint or similar protective coating after the joint has cooled.—ALL.

The Application of Aluminum Alloys to Marine Uses: An Introductory Survey. (AB/1.) Demy 4to. Pp. 44. 1948. London: The Aluminum Development Association, 33 Grosvenor Street, W. 1. (n.p.)—MA.

Light Alloys Used in Converting "Rochester Queen," *Light Metals,* **11,** No. 131, 682-683 (1948) Dec.

In converting the "Rochester Queen" from an Admiralty L.C.G. (M), extensive use was made of aluminum alloys. The whole of the upper deck, with its beams and girders, and the funnel and bridge house are built in Noral 65S plate and Noral 51S extruding sections. All non-aluminum fittings were bedded in felt and Duralac, and the fastenings galvanized or cadmium plated. Light-alloy rivets containing 5 per cent magnesium were used. When completed, the structure was thoroughly degreased and primed with zinc chromate which provided excellent adhesion when the top coats were supplied. The interior of the upper deck was finished in Holoplast wall panelling, the panels being outlined with aluminum extrusions.—ALL.

Fire Underwriters Give Approval for Aluminum. *Light Metal Age,* **6,** Nos. 11-12, 19 (1948) Dec.

The National Board of Fire Underwriters has approved aluminum for use in the installation of ducts for air conditioning, warm air heating, air cooling, and ventilating systems. The approval has been granted on the recommendation from the Committee on Air Conditioning of the National Fire Prevention Association. The Committee's recommendation is based on a careful study of aluminum's satisfactory performance in a large number of duct work applications.—ALL.

Yeoman Service. *Light Metals* (England) **12,** No. 133, 78-80 (1949) Feb.

The light alloy excavator bucket under consideration was constructed by Head, Wrightson Light Alloy Structure, Ltd., from materials supplied by Reynolds Rolling Mills, Ltd., for use in the construction of the London Air Port at Heath Row. The ⅝-cu. yd, bucket is fabricated from aluminum with steel lip plate, and reinforced to protect it from the pounding of the spreader bar. Steel rivets are used throughout. It has been in continuous service for 14 months during which time it has handled approximately 108,000 cu. yds. of sharp sand. For the same job and during the same period, four new steel buckets were introduced, repaired and finally scrapped. Because of its lighter weight the aluminum bucket does not strike the ground with so much force, and damage due to the effect of dropping, dragging across rough ballast when fully loaded and to the stresses imposed during lifting, is reduced. It has been suggested that the greater capacity of the metal for purely plastic deformation resulting from a lower modulus of elasticity enables it to yield to the forces responsible for abrasion and so escape the cuting action of the abrading particles. Alternatively, due to the relative softness of aluminum, sand particles become embedded in the surface, thereby improving wear resistance. A third theory is based on the assumption that wear in a steel bucket is due to the simultaneous occurrence of rusting and abrasion, whereby the oxide film formed is removed by the abrasive action of the following charge. Because no comparable rusting action can take place with aluminum, the abrasive action is less severe in its effect.—ALL.

6.2. 4.3, 5.9. 1.3, 3.7

Recent Research on Very Pure Aluminimum. G. Chaudron. *Helvetica Chimica Acta* (Switzerland) **31,** 1553-1570. (1948) Oct. 15.

Electrolytically purified aluminum (99.998%) was investigated in relation to passivity to HCl, preparation of the surface, kinetics of the oxidation of exposed aluminum, effects of corrosion, structure, and recrystallization.—ALL.

6.2

Improvements in the Corrosion Resistance of Magnesium and Aluminum and Their Alloys. I. G. Farbenindustrie. Board of Trade, Ger. Div. FD 1066/48. Frames 1-59.

Details of the claims made in seven patents which relate to the improvement of the corrosion resistance of Mg and Al and their alloys are given.—RPI.

6.2, 4.4, 3.5, 7.1, 4.6, 4.3, 7.4, 6.6

Titanium: The New Metal. G. A. W. Boehm. *Scientific American,* **180,** No. 4, 48-51 (1949) Apr. *Fortune,* **39,** No. 5, 121-124+ (1949) May.

Postwar development of processes for extracting and working Ti (titanium) into an almost pure state makes it a promising new structural material. Ti is 70% heavier and six times stronger than Al, about 40% lighter and nearly equal in tensile strength to steel and more corrosion resistant to salt water than stainless steel. Photographs of the metal at various stages of the Kroll process are given. Other processes for producing the metal are discussed. Chart compares properties of Ti with stainless steel and 75-S alloy. The melting point of Ti is 300° higher than iron but does not give as high heat resistance as expected, though it retains its strength at moderately elevated temperatures. With its great affinity for O_2, upon exposure to room temperature Ti acquires as impenetrable, invisible oxide coating which protects it from the atmosphere, salt water, and most acids, excluding principally sulphuric and hydrochloric. In a series of tests, Ti endured, without harmful effect, 600 hours of exposure at 190° F to fruit juices, onion in water, vinegar,

lard, tea, coffee, and lactic acid. Four months in sea water corroded Al, alclad Al, stainless steel (just a pit), and Monel but left Ti unscathed. Results as good as those with Ti can be obtained only from platinum ($72 oz.) or Hastelloy C ($3.80 lb.). In a 2200° F flame test Al burned through in 30 seconds. Half an hour of such heat left its mark on stainless steel, but hardly changed the appearance of Ti. However, the metal becomes brittle after short-term exposure to temperatures above 1300° F. The navy is studying its use in condenser tubes, shaftings, propellors, pump rods, hull plates for seaplanes, and pontoons. The air force is studying it for air frames, rocket, turbojet and ramjet engines. Its ability to hold its strength without much expansion between 300° and 800° F makes it a leading new candidate for jet-turbine blades. No full-scale production of Ti metal has yet been launched, but the sponge metal is currently selling for $5 a pound.—INCO.

6.2, 2.3, 4.6

Corrosion Behavior of Aluminum Alloys as Used in Ships' Structures and Fittings, Fifth Interim Report. Admiralty Corrosion Committees, Hull & Non-Ferrous Corrosion Sub-Committees, ACSIL/ADM/49/63, Metallurgical Report DMQ, *Journal of the British Shipbuilding Research Association* (England) **4,** No. 4, 209 (1949) Apr. *Light Metals Bull.*, **11,** No. 11, 494 (1949) June 3.

A detailed account is given of the first stages of the second part of a comprehensive investigation of the corrosion characteristics of light alloys exposed to half-tide conditions. In the present series of tests 13 alloys are being studied. The specimens each consist of two 6-in. x 6-in. plates riveted together through a 1-in. overlap. The aluminum panels are coupled either to similar aluminum panels or to galvanized steel. A painted and an unpainted specimen of each type are being used. The appearance of the specimens after a month's exposure is described in an appendix. The condition of most of the specimens involving aluminum alloys joined together and exposed unpainted is practically unchanged, although there are definite signs of nodular attack on the specimens of AW16, a fully heat-treated Cu-Mn-Zn alloy. Some of the cast panels show traces of white nodules of corrosion product in the heads and points of the rivets. The condition of the aluminum alloys joined to galvanized steel is excellent, with the exception of the AW16A specimens which show a slight nodular attack in areas remote from the steel. The galvanized steel panels all have a thin white coating of oxychloride. All the painted specimens are in excellent condition.—ALL.

6.2

Aluminum Replacement Fenders for Pontiacs. *Automotive Industries,* **100,** No. 1, 34, 67-68 (1949) Jan. 1.

Because of the continuing steel shortage Pontiac is making a number of aluminum rear fenders for service replacement on 1942, 46, 47 and 48 models. When installing the fenders the company recommends the exclusive use of cadmium-plated or zinc-plated bolts, nuts and washers that have been painted with primer. The fenders themselves are given a bonderite treatment, a zinc chromate primer and then painted light green. When the finish has been removed to the bare metal a special repair technique is recommended. The metal should first be thoroughly cleaned by sanding and by the use of a solvent wash, applying a warm 5 percent sodium dichromate or potassium dichromate solution. Then a zinc chromate primer, surfacer, and finish coats may be applied in accordance with standard practice. The final step consists in applying a coat of asphalt-base sheet metal deadener to the underside of the fender.—ALL.

6.2

Corrosive Distintegration of Cast Magnesium Alloys. E. M. Zaretski *Journal of Applied Chemistry* (USSR), **20,** No. 9, 830-836 (1947) Sept. *Guide to Russian Scientific Periodical Literature* (USA), **2,** No. 2, 57 (1949) Feb.—ALL.

6.2

Developments in Alloys Containing Nickel. L. B. Pfeil. *Metallurgia,* **39,** 81-86 (1948) Dec.

This article contains a reference to the use of nickel-aluminum bronze as material for the blades of variable-pitch propellers. The author states that there is no doubt that the alloy containing 3.0-5.5 percent nickel and iron, as covered by B.S. 1073, will be increasingly employed instead of high-tensile brass, for specialized applications where strength, corrosion-resistance and reliability are required. Nickel-aluminum bronze, to the above specification, has four times the resistanec of high-tensile brass to cavitation-erosion in sea water, a tensile strength and elongation of not less than 40 tons per sq. in. and 12 percent, respectively, and a corrosion-fatigue value in sea water of between ±8.5-±10.5 tons per sq. in., on a basis of 50 million reversals.—TIME.

6.2

Aluminum and Zinc Base Alloys. Anon. *Pract. Eng.,* **19,** No. 485, 537 (1949) May 20.

A memorandum giving guidance on the use of aluminum and zinc alloy die cast conduit installations, issued by the Council of the Institution of Electrical Engineers on behalf of the Wiring Regulations Committee. The notes are mainly concerned with the precautions which should be taken to prevent corrosion under certain peculiar conditions of exposure. In damp locations direct contact must not occur between aluminum alloy conduit and other metals which might cause electrolytic corrosion. In corrosive atmospheres, protective paints should be applied, and all non-ferrous components in contact with corrosive plasters, cements, etc., or acid-containing timbers, should be coated with bitumen or bituminized paint. Aluminum alloy conduit and die cast fittings, being less strong than steel, need more careful handling during installation.—ZDA.

6.2

Commercial Aluminum Casting Alloys. W. E. Sicha. ASM. "Physical Metallurgy of Aluminum Alloys," **1949,** 129-166.

Reviews properties and applications of the various alloys and the finished castings. Includes amenability to heat treatment and corrosion resistance. Compositions, physical and mechanical properties, and recommended heat treatments are tabulated.—BLR.

• Non-Metallic

6.3, 3.5

Ceramic Materials for High-Temperature Mechanical Parts. J. R. Bressman. *Metallurgia,* **37,** No. 221, 279, 281-2[illegible] (1948) Mar.

Development of solid ceramic shapes for high temperature parts and of ceramic coatings to protect metals from corrosion at high temperatures is discussed.—INCO.

6.3

Experiments in the Use of High Vacua and Wetting Agents in the Preservative Treatment of Green Douglas Fir Lumber. H. W. Angell, V. F. Hribar and W. A. McFarland. Amer. Lumber & Trading Co., Pamphlet, 11 pp. (1948); *Prev. Det. Abs.,* **5,** W 37 (1948).—RPI.

6.3, 3.3, 5.8, 2.2

Results of the Examination of Seven Ground-Line Treatments on Eastern White Cedar Pole Stubs After Six Years' Service. J. F. Harkom, M. J. Colleary, and H. P. Sedziak. Can. Forest Service Forest Products Lab., 14 pp. (1948); *Prev. Det. Abs.,* **5,** W 30 (1948).

Various treatments using creosote, sodium fluoride and copper-naphthenate were employed. All treatments were effective in inhibiting decay at the ground-line for 6 yr. Combined creosote and salt was the most effective below the ground-line.—RPI.

6.3

American Wood Preservers' Association Tie Service Tests. Report of Committee 7-1—Tie Service Records. Amer. Wood Preservers Assoc., 24 pp. (1948); *Prev. Det. Abs.,* **5,** W. 56 (1948).

The results of railroad tie service tests in which the timber was pretreated with zinc chloride, creosote and various creosote/petroleum or creosote/coal tar mixtures are given. Air-seasoned ties treated with an 80:20 mixture of creosote and refined coal tar gave an average expected life of 37 years.—RPI

6.3

Treatment of Heartwood and Sapwood Boards with Acid Cupric Chromate Preservative Against Marine Borers. U. S. Naval Base, 1948, Rept. No. 2098-D; *Prev. Det. Abs.,* **5,** W. 26 (1948).—RPI.

6.3

American Wood Preservers' Association Pole Service Records. Report of Committee 7-7, Pole Service Records, 4 pp. (1948); *Prev. Det. Abs.,* **5,** W. 58 (1948).

Service records of a line of creosoted Douglas fir poles and creosoted lodgepole pine poles indicate that deterioration at the ground line is due to insufficient penetration of preservative. Accidental perforation of the treated wood during handling may also permit infection to reach inner sap wood and heartwood.—RPI.

EQUIPMENT

• Engines

7.1, 5.1, 5.8

Diesel Engines and Their Fuels. P. H. Everett, paper presented to Joint Conf. of Inst. of Fuel & Petro., Sept. 23, 1948. *The Motorship,* **29,** 273-275 (1948) Oct.

This paper refers to the problem of the grades of fuels required by high speed and slow speed Diesel engines. The burning of fuel oil in a Diesel engine involves: a) Cleaning the fuel oil of all water and adventitious matter. b) Correct combustion chamber, pump

d injector. c) Adequate cooling of the jector tip.

The author explains that cooling of e sprayer tip is most important and an be helped considerably by the design f the component parts being arranged o convey the heat away. Cooling, to be fficient, must be right at the nozzle tip. he best design is that used in the Dox-rd engine. It will be noticed that cool-g is very thorough and that, the me-ium, water in this case, is brought very lose to the fuel just as it is entering the ylinder. The cooling space of sprayer an be circulated with water or fuel oil -lubricating oil has been tried but ound unsatisfactory. Fuel oil having nly half the specific heat cannot be so fficient as water, and to get the best ffect water must be used. Corrosion an be prevented by suitable treatment f the sprayer parts or by an inhibitor dded to the water. The position of the prayer in the cylinder head with refer-nce to the combustion chamber is im-ortant, and when deciding this arrange-ents should be made to direct the flow f the incoming cylinder-head cooling ater on to the place where the sprayer s located.—TIME.

• Valves and Pipes

72

Aluminum Pipe Prevents Corrosion. *Am. Exporter Industrial,* **144,** No. 2, 535 (1949) Feb.

A 2-mile welded aluminum pipe line was recently completed by Interstate Pipe Line Co. to replace steel pipe badly corroded by "sour" oil. Due to the light weight of aluminum, 40 ft. lengths were easily handled and hence only half as many welds were required as with standard 20-ft. steel pipe. Roll welding was employed. After lining up and tacking each joint, the weld was completed in two passes, requiring only 14 minutes.—INCO.

7.2, 8.4, 6.2, 3.5, 6.1

Corrosion and Stress Factors in Piping Expansion Joint Failures. H. F. Brown and W. M. Goryl. S. O. Dev. Co. (Preprint, API 14th Mid-Year Meet., Refg. Div., Houston, 9 pp. (4/4-7/49).

Types of corrosion failures encountered in bellows-type piping expansion joints used in fluid catalytic cracking units include erosion by bypassing of the inner protecting sleeve which permits erosion of the bellows edges, general surface corrosion and pitting of the bellows elements, and cracking of the bellows elements. Photographs of failures in austenitic chrome-nickel alloys are included. Investigation of actual stresses present when an expansion bellows is subjected to pressures and movements indicated that stresses far in excess of the elastic limit occurred when joints were subjected to movements within the manufacturers' rating. A theoretical and actual stress analysis of flat disc-type joints revealed an optimum relationship for the disc thickness and width which permits the maximum movement for a given pressure and allowable stress. Stress equations indicated that maximum deformation per disc varies: a) as the square of the design stress, b) directly with the thickness of the discs and c) inversely with pressure and modulus. It was concluded that 18% chromium-8% nickel type 347 alloy has the most desirable properties for expansion joint construction, using a design stress of 25,000 psi and Young's modulus equal to 28.5 x 10^6 psi.

• Containers

7.5

Gas Cylinders. *Iron and Steel,* **22,** 95 (1949) Mar.

Discusses recent work on corrosion and its prevention. Outlines recent German research. Gives references to original German publications.—BLR.

7.5, 8.4, 4.4

Corrosion in Sour Crude Storage Tanks. D. Holsteyn, Shell Oil Co., Inc. *Corrosion,* **5,** No. 5, 168 (1949) May.

Photographs of corroded sour crude storage tanks show: 1) corrosion products cumulated in the vapor space of the tank roof during 40 months of service, and 2) same area with some of the corrosion products removed. Analyses are given of products next to vapor space and next to steel.—INCO.

7.5, 8.4, 4.4, 5.7, 3.5

Crude Still Overhead System Corrosion. A. F. Blumer. Paper before NACE, Sept. 20, 1948, S. Central Region, Tulsa. *Corrosion,* **5,** No. 5, 135-145 (1949) May.

Paper discusses corrosion occurring in overhead equipment of crude distillaunits. Corrosive action of hydrogen sulphide, carbon dioxide and hydrogen chloride is described. Selection of materials, combating corrosion by crude desalting, sulphide removal and neutralizing acidic constituents, stress corrosion cracking, failures in Admiralty tubes and corrosion fatigue are dealt with. Photographs are included.—INCO.

7.5, 6.1, 6.2, 4.4, 8.4, 5.3

Initial Operation of Continental's Catalytic Cracker. J. E. Fenex, Continental Oil Co. A. W. Hoge and L. Friedman, Houdry Process Corp. *Petro. Ref.,* **28,** No. 8, 103-106 (1949) Aug.

For corrosion protection against the high-sulfur stocks, alloy liners were used in critical locations, 11-13 chrome steel liners were installed in the tar separator and the bottom section of the synthetic crude tower. An 18-8 alloy lining was added to the reactor.—INCO.

7.5, 6.2, 4.2, 8.9

Light Alloy Hatch Beams. F. Boyles. *Shipbuilding and Shipping Record,* **73,** 145-48 (1949) Feb. 3.

The employment of aluminum and its alloys in many ships and boat building applications is today an established practice, but, up to the present, their use has been limited so far as structural and stressed members are concerned. In considering what parts of a ship's structure and equipment might be reduced in weight by employing aluminum alloys, hatch beams are deserving of particular attention. These parts are manhandled on every occasion the ship is loaded and unloaded, and at sea the larger proportion of them are above the center of gravity. After discussion of this particular application with the superintendent engineer of one of the principal shippng lines, it was decided by I.C.I. to review the comparative weights, strength and characteristics of a light alloy hatch beam and its mild steel counterpart. It was considered that to obtain information of the greatest value, it would first be necessary to procure a steel beam of a type in general use and to design and build a light alloy beam which would correspond with it in general principles. For this purpose Cammel Laird and Co. supplied a hatch beam identical with one of the types in service on the steamship Robert L. Holt, a vessel of 5000 tons d.w. The light alloy beam was built in magnesium silicide alloy "knal" in the fully heat treated condition except for the rivets which would have to be in the solution heat-treated condition. This alloy has a high resistance to corrosion in marine atmospheres. From the report of the tests made under the direction of Prof. C. Batho of the University of Birmingham, it has been concluded that the tests described demonstrate that the hatch beam fabricated from light alloy material afforded advantages over mild steel since an appreciable saving of weight was effected without sacrifice of mechanical strength. In fact, the light alloy beam showed a 56 percent saving in weight and permitted 30 percent greater loading than the mild steel beam before the limit of proportionality was reached.—TIME.

INDEX TO ADVERTISERS

APRIL, 1950

Vol. 6 No. 4

	Page
Allied Chemical & Dye Corp. Barrett Division	17
Alox Corporation	23
American Cast Iron Pipe Co.	20
American Smelting & Ref. Co. Federated Metals Div.	26
Bechtel Corp. & H. C. Price	9
Brance-Krachy Co.	41
Bristol Company, The	7
Calgon, Inc.	ix
Cathodic Protection Service	16
Cathodic Servicing Co.	35
Corrosion Directory	21
Crose, M. J., Co.	10
Dampney Co.	14
Dearborn Chemical Co.	Inside Front Cover
Dixie Tank & Bridge Co.	6
Dow Chemical Co. (Saran Lined Pipe Co.)	13
Dowell, Inc.	ii
Dresser Mfg. Division	29
Electro Rust-Proofing Corp. (N.J.)	4
Fisher Research Laboratory, Inc.	14
Good-All Electric Mfg. Co.	31
General Paint Corp. Hill, Hubbell Div.	48
Haering, D. W. & Co.	8
Hills-McCanna	25
International Nickel Co., Inc., The	vii
Johns-Manville	viii
Koppers Co., Inc.	39
Mayes Bros., Inc.	xi
Midwestern Engine & Equip. Co.	vi
Mutual Chemical Company	15
National Association Corrosion Engrs.	Inside Back Cover
National Carbon Division Union Carbide & Carbon Corp.	37
Perrault Bros.	5
Pipe Line Service Co.	27
Pittman, Wm. G.	20
Pittsburgh Coke & Chemical Co.	33
Plastic Lining Corp.	19
Saran Lined Pipe Co. (Dow Chemical Co.)	13
Service Engineers, Inc.	12
Stearns, D. E.	Back Cover
Tapecoat Co., The	18
Union Carbide & Carbon Corp. National Carbon Division	37
Williamson, T. D., Inc.	11

THE PIPE LINE ENGINEER'S SUREST ANSWER TO

"...highly corrosive conditions"

In addition to steep slopes, bends, and narrow right-of-way, pipe line engineers installing this 20" loop line faced what they termed "highly corrosive conditions."

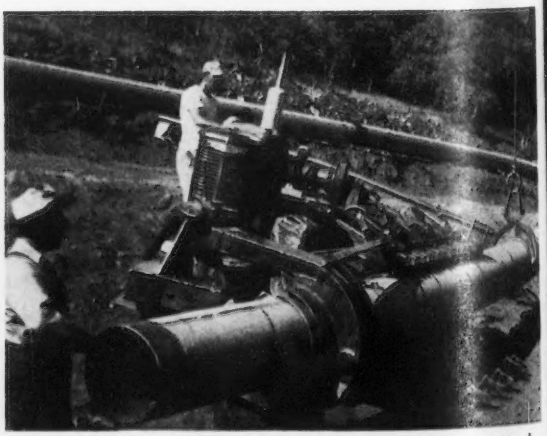
Even the toughest pipe protection problems get solved when you call in Hill, Hubbell...

Every pipe line is an *individual* protection problem. That's why so many firms work with Hill, Hubbell right from the initial plans stage. Drawing on a quarter-century's experience, Hill, Hubbell experts make sure the pipe gets the kind of insulation the *specific* job requires . . . and that it's scientifically-applied at the *factory* to provide longest possible resistance against every agent of corrosion. Before your next job—wire, phone, or write...

Hill, Hubbell and Company

Division of GENERAL PAINT CORPORATION

Headquarters: 3091 Mayfield Road, Cleveland 18, Ohio



Hill, Hubbell field men helped lick the extremely difficult problems faced in installing this new Rocky Mountain natural-gas line. Today it is in successful operation—sealed and safeguarded for years of trouble-free operation.

CORROSION LITERATURE

Available From

NATIONAL ASSOCIATION OF CORROSION ENGINEERS

BIBLIOGRAPHIC SURVEY OF CORROSION, 1945

Single copy postpaid to members of the Association $4.00
To non members of the Association 5.00

JOINT SYMPOSIUM ON CATHODIC PROTECTION

To members of the Electrochemical Society and National Association of Corrosion Engineers, per copy 6.00
To all others, per copy 8.00

PROCEEDINGS, FIRST ANNUAL MEETING, NACE

Single copy postpaid to members of the Association 3.00
To non members of the Association 6.00

DIRECTORY, AMERICAN COORDINATING COMMITTEE ON CORROSION

Single copy, postpaid 2.00

CONTROL OF PIPE LINE CORROSION

by O. C. Mudd

Single copy, postpaid $1.25
(Five or more copies to one address, postpaid at $1.00 per copy)

SELECTED BIBLIOGRAPHY ON SALT SPRAY TESTING

by Lorraine R. Voigt

Single copy, postpaid ..... $ .50

THE MITIGATION OF CORROSION ON CITY GAS DISTRIBUTION SYSTEMS

by A. D. Simpson, Jr.

Single copy, postpaid ..... $ .50

CAUSES OF CORROSION IN AIRPLANES AND METHODS OF PREVENTION

N. H. Simpson

Single copy, postpaid ..... $ .50

THE USE OF AMMONIA IN CONTROL OF VAPOR ZONE CORROSION OF STORAGE TANKS

by F. T. Gardner, A. T. Clothier and F. Coryell

Single copy, postpaid ..... $ .50

CORROSION Magazine

Most back issues are still available
Single copies to members, postpaid ..... $ .50
Single copies to non-members, postpaid ..... $ .75

To: NATIONAL ASSOCIATION OF CORROSION ENGINEERS

919 Milam Bldg., Houston 2, Texas

Please send me the following publications:

Quantity

( ) Bibliographic Survey of Corrosion
( ) Joint Symposium on Cathodic Protection
( ) Proceedings, First Annual Meeting
( ) Directory, American Coordinating Committee on Corrosion
( ) Control of Pipe Line Corrosion
( ) Selected Bibliography on Salt Spray Testing
( ) The Mitigation of Corrosion on City Gas Distribution Systems
( ) Causes of Corrosion in Airplanes and Methods of Prevention
( ) The Use of Ammonia in Control of Vapor Zone Corrosion of Storage Tanks
( ) CORROSION Magazine [Indicate month ( ) and year ( )]

Name .....

Street .....

City ..... Zone ..... State .....

I am (not) a member of NACE.
Check one: I wish to be billed for these publications at . $ .....

I am enclosing a check for $ .....

★ Thorough Inspection ★ Light Weight
★ Simple to Operate ★ Dependable Service

D. E. STEARNS
SHREVEPORT, LOUISIANA

POST OFFICE BOX 4234

A Dependable Organization
providing the
Finest Holiday Detector Equipment
for the
Entire Pipe Line Industry

Via Air - Anywhere

BETTER COATINGS CONSERVE STEEL